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VOLUME 15

1968-1969

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GEOGRAPHIC AND SEASONAL VARIATION IN SMITH'S LONGSPUR, *CALCARIUS PICTUS*

JOSEPH R. JEHL, JR.

TRANSACTIONS

OF THE SAN DIEGO
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VOL. 15, NO. 1, 8 JANUARY 1968

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GEOGRAPHIC AND SEASONAL VARIATION IN SMITH'S LONGSPUR, *CALCARIUS PICTUS*

Joseph R. Jehl, Jr.

ABSTRACT

Color differences that have been used to define races of Smith's Longspur result from seasonal wear and fading of the breeding plumage. There is no demonstrable geographic variation in this species.

Smith's Longspur (*Calcarius pictus*) is an endemic species of the Nearctic subarctic avifauna (Johansen, 1963) that breeds from north-central Alaska eastward to Cape Henrietta Maria, Ontario (A.O.U., 1957; Gabrielson and Lincoln, 1959; Godfrey, 1966; Kemsies, 1961); apparently a small population breeds in northwestern British Columbia (Rand, 1948; Weeden, 1960). Owing to insufficient data from Alaska and central Canada, the breeding distribution of this species cannot be mapped accurately. The map (Fig. 1) is based on the assumption that throughout its range, as at Churchill, Manitoba (Jehl, Ms.), Smith's Longspur breeds primarily in the narrow belt of tundra bordering the treeline (*i.e.*, the forest-tundra of Johansen, 1963).

In a recent study, Kemsies (1961) argued that three subspecies of Smith's Longspur should be recognized. The approximate ranges of these races are shown in Figure 1. According to Kemsies, males in breeding plumage from north-central Alaska (*C. p. roweorum*) are browner dorsally and deeper orange ventrally than males of the nomi-

Figure 1. Presumed breeding range of Smith's Longspur. The distribution of the races recognized by Kemsies (1961) is indicated.

nate race, which breeds from extreme northeastern Alaska to the northeastern corner of Manitoba. Males from the Hudson Bay Coast of Ontario (*C. p. mersi*) are blacker dorsally and paler ventrally than nominate *pictus*. Thus, from west to east male Smith's Longspurs exhibit increasing blackness of the dorsum but increasing paleness of the venter. The apparently well-marked racial differences are clearly illustrated in Kemsies' Figure 1 (1961: 144). Females show parallel though less conspicuous clinal variation.

In the summers of 1965, 1966, and 1967, I studied the breeding biology of Smith's Longspur at Churchill, Manitoba (Jehl, Ms.). Specimens collected for data on reproductive biology and feeding habits were taken without conscious selection throughout the summer, except that in 1966 and 1967 I selected for territorial or known breeding birds. I made no attempt to sample plumage variation present in the population at any one time, nor to collect birds that appeared to be migrating.

Since Churchill is in the eastern half of the range of *C. p. pictus*, I was surprised to discover breeding birds fitting the description of each of the alleged races in my sample. Further study showed that variation in the Churchill population is clearly attributable to seasonal wear and fading of the breeding plumage. Birds collected in the first days of June are brightly colored and can be referred to *rowcorum;* throughout most of June *pictus* predominates; by late June the first *mersi* appear and by mid-July the entire population is dark-backed and pale-bellied. The seasonal variation in males is shown in Figure 2 (*cf.* Kemsies' Fig. 1; 1961: 144). The specimens illustrate approximately average plumage coloration and wear in the population at the time they were collected. I emphasize that they represent breeding birds. There is no possibility that birds taken in June were migrants to Alaska, where nesting commences earlier than at Churchill (Irving, 1960: 124-125), or that the July birds were post-breeding wanderers from Ontario. Females do not show such extreme seasonal variation, presumably because of their reduced activity during incubation.

A re-examination of Kemsies' data suggests that he was misled by biased sampling and inadequate material, and that seasonal rather than geographic variation accounts for the differences he recognized. For example, *14* of the 15 Alaskan specimens that he assigned to *rowcorum* were collected between 27 May and 9 June (type collected 4 June), when birds are still in relatively unworn plumage. *The entire series* of *mersi* from Ontario (45 specimens) was collected between 22 June and 10 August (type collected 31 July); most of these specimens can be expected to show advanced stages of wear and fading.

Inadequate samples plus seasonal variation could also explain several of Kemsies' additional, and otherwise puzzling, findings.

1. The existence of three well-marked races along a narrow belt of tundra that is not interrupted by any obvious barriers to gene flow.

2. The small breeding ranges of *rowcorum* and *mersi.*

3. The opposite trends in clinal variation of dorsal and ventral coloration noted above.

4. The abundance of *rowcorum* during migration. Kemsies referred *51* of 66 specimens collected south of the breeding grounds in April and May to *rowcorum* and the remainder to *pictus*. If those assigned to *rowcorum* are other than freshly molted individuals, it is difficult to explain the far greater abundance of the race with the much smaller breeding grounds, especially since Gabrielson and Lincoln (1959: 818) state that Smith's Longspurs are not common in Alaska.

Disproportionate numbers of *rowcorum* also occur in fall. Of 24 specimens taken away from the breeding grounds between 15 August and 30 October, Kemsies assigned *21* to *rowcorum*, 3 to *pictus*, even though he gave no criteria by which the races could be distinguished in the nonbreeding plumage! If he assumed that *rowcorum* would be

Figure 2. Seasonal plumage variation in male Smith's Longspurs collected at Churchill, Manitoba. Top and bottom, left to right: 2 June 1966; 9 June 1967; 11 June 1966; 16 June 1965; 25 June 1966; 1 July 1966; 11 July 1966.

browner at all seasons, he would have consequently assigned most of the fresh-plumaged birds to that race.

5. The virtual absence of *mersi* away from the breeding grounds. Kemsies lists only one migrant specimen of *mersi* (Hamilton, Kansas, 21 March 1914). Since the breeding range of this subspecies is approximately as large as that of *rowcorum*, and since *mersi* would appear to be relatively common on the Ontario coast (26 specimens collected in 1948, alone), the relative disproportion is especially notable.

6. The relative abundance of the races in Ohio. Smith's Longspurs do not normally occur east of Ohio and one would predict that many, perhaps most, of the spring migrants in that state would be referrable to the easternmost breeding population. Yet, 15 of the 20 specimens listed by Kemsies taken between 19 March and 24 April are assigned to *rowcorum* and the remainder are classified as *pictus*. However, if the alleged geographic variation is seasonal, the racial identifications and the absence of *mersi* are not surprising, for at this season birds are molting into fresh plumage and are unworn.

Through the courtesy of the curators acknowledged below, I have been able to examine most of the specimens from the breeding grounds on which Kemsies based his descriptions, and to compare them with seasonally comparable material from Churchill. Specimens examined (see Appendix) included 19 from Alaska, including the type of *rowcorum*, 21 from the Northwest Territories, 35 from Churchill, and 38 from the Ontario coast, including the entire series of *mersi* paratypes. Of these 65 per cent had been examined previously by Kemsies. My study confirmed that seasonal variation was the basis for Kemsies' conclusions. *All* specimens from Churchill and those that Kemsies had assigned to *pictus* were indistinguishable from those assigned to *rowcorum* or *mersi*, *provided they were compared with specimens taken at the same stage of the breeding cycle and were in a comparable stage of wear.* Moreover, even some slightly worn specimens of *rowcorum* from Alaska (*e.g.*, U. S. National Museum no. 454878, Summit, Alaska, 3 June 1952) were inseparable from relatively unworn specimens of *mersi* (*e.g.*, Royal Ontario Mus. Zool. no. 93557, 20 mi. S. Cape Henrietta Maria, 14 July 1948). Furthermore, I found no differences between several juveniles from Churchill and one from the Ontario coast, or between Churchill birds in fresh non-breeding plumage and a specimen from Alkavik, NWT, previously assigned to *rowcorum*. Ontario birds in non-breeding plumage and Alaskan juveniles were not available.

Kemsies' data did not indicate geographic size variation in this species. I also found no differences between Churchill and Alaskan birds (Table 1); unworn specimens from Ontario were not available for comparison. The wing and tail measurements of Churchill males taken in late July average nearly 2 mm shorter than those collected in early June. To reduce possible error, the dimensions of males collected after 20 June were not included in Table 1.

TABLE 1

Measurements of Smith's Longspurs[1]

	Exposed Culmen			Wing (Chord)			Tail			Tarsus		
	No.	Range	and Mean	No.	Range	and Mean	No.	Range	and Mean	No.	Range	and Mean
Churchill males	18	9.9-11.7	(10.6)	11	88-94	(91.8)	11	59-67	(63.7)	18	20-22	(20.9)
Alaskan males	13	9.9-11.4	(10.6)	13	87-95	(92.2)	12	57-65	(62.5)	13	20-23.5	(20.9)
Churchill females	9	9.9-11.4	(10.4)	9	84-90	(87.5)	9	57-60	(58.8)	9	20-23.5	(20.9)
Alaska females	4	9.7-10.3	(10.0)	6	87-91	(88.4)	6	58-62	(60.0)	6	20-21.5	(20.6)

[1]Culmen measured to nearest 0.1 mm, tarsus to nearest 0.5 mm, wing and tail to nearest 1 mm. Wing and tail measurements from Churchill males collected after 20 June are omitted (see text for explanation). All Alaskan specimens were collected on or before 20 June.

In summary, Smith's Longspur shows no taxonomically recognizable geographic variation in either plumage coloration or size. Therefore, acceptance of the proposed races must be withheld.

ACKNOWLEDGMENTS

I am grateful to the Frank M. Chapman Fund of the American Museum of Natural History, The University of Michigan, the National Science Foundation, and the San Diego Society of Natural History for supporting my field work at Churchill, Manitoba. The following persons kindly made specimens available for study: Richard C. Banks and Richard L. Zusi, United States National Museum; Jon C. Barlow, Royal Ontario Museum of Zoology; Tom J. Cade, Cornell University; W. Earl Godfrey, National Museum of Canada; Kenneth C. Parkes, Carnegie Museum.

W. Earl Godfrey, Harrison B. Tordoff and D. J. T. Hussell offered helpful suggestions on the manuscript.

LITERATURE CITED

AMERICAN ORNITHOLOGISTS' UNION
1957. Check-list of North American birds. Fifth ed.

GABRIELSON, I. N., and F. C. LINCOLN
1959. The birds of Alaska. Stackpole Co., Harrisburg, Penna., and Wildlife Management Inst., Washington, D.C.

GODFREY, W. E.
1966. The birds of Canada. Nat. Mus. Canada Bull. 203.

IRVING, L.
1960. Birds of Anaktuvuk Pass, Kobuk, and Old Crow. U. S. Nat. Mus. Bull. 217.

JEHL, J. R, JR.
Ms. The breeding biology of Smith's Longspur, *Calcarius pictus*.

JOHANSEN, H.
1963. Zoogeographical aspects of the birds of the subarctic. Proc. XIII Intern. Ornithol. Cong.: 1117-1123.

KEMSIES, E.
1961. Subspeciation in the Smith's Longspur, *Calcarius pictus*. Canad. Field-Nat. 75: 143-149.

RAND, A. L.
1949. Distributional notes on Canadian birds. Canad. Field-Nat. 62: 175-180.

WEEDEN, R. B.
1960. The birds of Chilkat Pass, British Columbia. Canad. Field-Nat. 74: 119-129.

MANUSCRIPT RECEIVED 23 OCTOBER 1967

APPENDIX

SPECIMENS EXAMINED

ALASKA. Anaktuvuk Pass (8): June 3, 4 (3), 5, 8, 19, 20. Summit (2): June 3, 9. Giant Creek (1): June 2. Tolugak Creek (7): May 27, 28 (2), 29, June 4, 5, 9. Contact Creek (1): June 20. MACKENZIE DISTRICT, NWT. Fort Good Hope (3): May 31. Fort Simpson (16): May 18, 20 (10), 21 (2), 25 (2), 26. Aklavik (2): May 26, August 19. MANITOBA. Churchill (35): June 2 (2), 4 (3), 9 (4), 11 (3), 13, 16 (3), 18, 25, 30, July 1, 9, 11 (2), 13 (2), 15, 16 (2), 22, 24, August 12 (2), 25, 26 (2). ONTARIO. Little Cape (9): July 29, 31 (5), August 1 (3). Fort Severn (6): June 22 (2), 27 (2), July 1, 14. Winisk (1): June 30. 54 mi. below Hawley Lake (1): June 22. Wachee Creek (1): June 25. Cape Henrietta Maria (19): July 2 (2), 3 (3), 5 (3), 7, 9 (2), 12 (2), 14 (6). 20 mi. S. Cape Henrietta Maria (1): July 14.

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NEW PANAMIC NUDIBRANCHS (GASTROPODA; OPISTHOBRANCHIA) FROM THE GULF OF CALIFORNIA

JAMES R. LANCE

TRANSACTIONS

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VOL. 15, NO. 2, 8 JANUARY 1968

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Plate 1. *Nembrotha hubbsi*, sp. nov. Kodachrome by Wesley M. Farmer.

Plate 2. *Acanthodoris stohleri*, sp. nov. Ektachrome by Walter E. Harvey and James R. Lance.

NEW PANAMIC NUDIBRANCHS (GASTROPODA: OPISTHOBRANCHIA) FROM THE GULF OF CALIFORNIA

James R. Lance[1]

ABSTRACT

Three new species of shell-less euthyneuran mollusks from the northern part of the Panamic faunal province are described. These are: *Chromodoris fayeae* sp. nov., *Acanthodoris stohleri* sp. nov. and *Nembrotha hubbsi* sp. nov. The last taxon represents the first record for this genus in the eastern Pacific. Other northeastern Pacific species of the treated genera are compared and discussed. Anatomical details and geographic ranges are provided.

Although some 1600 species of mollusks have been reported from the Panamic faunal province (Keen, 1958: 7), only 20 species of nudibranchs (Order Nudibranchia) are known from the region. This small number of species reflects a general disinterest of malacologists in observing and collecting shell-less mollusks and, in part, the inaccessibility of the region, rather than a paucity of material. Expeditions to the Gulf of California undertaken between 1962 and 1967, by the San Diego Natural History Museum, the Santa Barbara Museum of Natural History, and the writer, have collected large numbers of these animals. These collections apparently include many new species, of which three are described below. Numerous individuals of each species from different geographic localities have been compared and color transparencies have been made of the animals in life. The illustrations portray typical individuals from the obtained samples. The systematic treatment follows Odhner's (1939) revision.

Species Accounts

Family Doridídae
Subfamily Chromodoridinae
Chromodoris fayeae sp. nov.

Type material. — Holotype: California Academy of Sciences, Department of Invertebrate Zoology no. 314. Collected 6 March 1966 in the rocky, lower intertidal region at Santa Cruz, Nayarit, Mexico (approximately ten miles south of San Blas); 21°30′N, 105°16′W. Paratypes: Santa Barbara Museum of Natural History nos. 19669 (two specimens collected 6 March 1966) and 25000 (15 specimens collected 4 February 1967).

Description. — The largest specimen measured 47 mm long and 11 mm broad while crawling actively. The notum is moderately expanded in front and behind, narrower in the middle and completely covers the foot except posteriorly where the pointed tail protrudes (Fig. 1). The notal surface is soft and smooth, its margins entire when the animal is gliding, but it may become crenulate when the animal is irritated. The vertical sides of the body are completely covered by the notum, and are not partially exposed as in *Hypselodoris californiensis* (Bergh, 1879).

The spectacular color pattern of *C. fayeae* at once distinguishes it from all other described northeastern Pacific opisthobranchs. The general ground color is pure white, not the colorless translucency of many other species. Three distinct, uninterrupted lines of contrasting color occur around the notal brim: an inner band of opaque white, which contrasts with the pellucid white of the body, a central line of vivid red, and a

[1]Stazione Zoologica di Napoli. Present address: 746 Agate St., San Diego, California 92109.

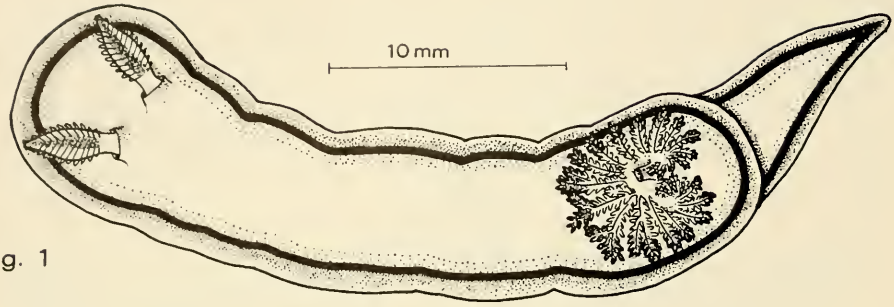

Fig. 1

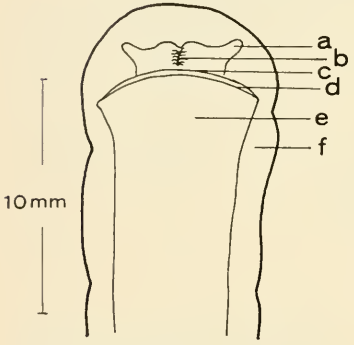

Fig. 2

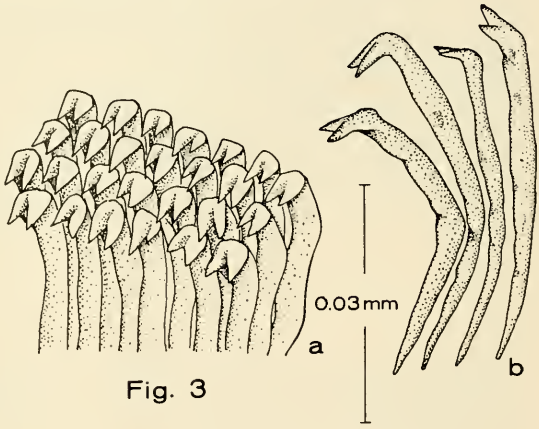

Fig. 3

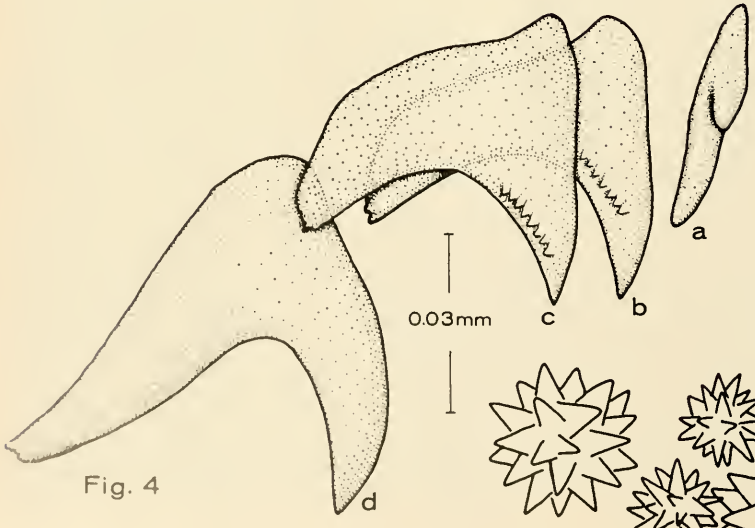

Fig. 4

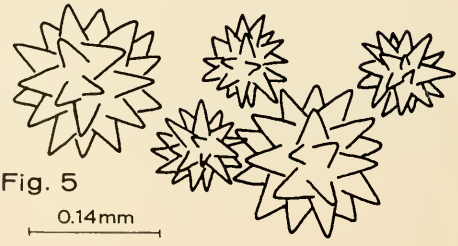

Fig. 5

marginal edging of brilliant yellow. This same pattern is repeated around the foot margins. It is most intense posteriorly and gradually fades anteriorly and disappears at about the level of the rhinophores. The inner and outer surfaces of the distal portions of the branchial stems are red. The perfoliate regions of the rhinophores are colored a similar but darker red, especially on their anterior and posterior axial ridges. Some preserved specimens retained a faint trace of red after one year in 70 per cent isopropyl alcohol, but this was lost after the second year. The opaque white and yellow bands faded two months after preservation.

Anteriorly the foot is expanded and produced into sharp corners (Fig. 2). Its frontal margin is rounded, deeply bilabiate and entire, not notched. The lateral margins are nearly parallel except posteriorly, where they converge to form a pointed tail with a low dorsomedian crest. The anterolateral corners of the head are produced into short, digitform tentacles, between which the mouth appears as a longitudinal slit (Fig. 2a, b).

The rhinophores are completely retractile into chambers which bear sheaths with low, smooth margins. These sensory organs are relatively short but deeply perfoliate with 21 lamellae (in a 36 mm specimen) joined by a longitudinal septum on both the anterior and posterior faces.

The elegantly developed branchiae are simply pinnate, although some of the anterior primary stems may bifurcate distally. They are completely retractile within a cavity bearing a low, smooth margin and are disposed in an arc with enrolled extremities similar to those described and figured by Eliot (1904) for several species of Indo-Pacific chromodorids. The 24 to 32 branchiae gradually decrease in size toward the extremities of the enrolled arc. Except for momentary periods of quiescence, these appendages are continually in motion. The movement of each branchium is a rapid twitching from side to side and is entirely unlike the rhythmical circulatory pulsations observed in the respiratory appendages of many other cryptobranch dorids. Eliot (1904) has reported similar branchial motion for *Chromodoris annulata*, *C. runcinata*, *C. tryoni* and *Casella atromarginata*. Gohar and Aboul-Ela (1957) have observed sideward vibrations in *Chromodoris pulchella* and *C. annulata* from the Red Sea. Such a respiratory adaptation is obviously advantageous to organisms inhabiting waters low in dissolved oxygen.

The labial armature consists of a horn-colored, circular band of minute rodlets arranged in an irregular series. Each rodlet is flexed near its midpoint (from nearly straight to about 90°) and terminates in a bifid cusp (Fig. 3b). From above, only the bifid hooks and portions of their supporting rods are evident (Fig. 3a). Bergh (1905, pl. 16) figures similar labial elements for a number of Indo-Pacific chromodorids.

The radula is broad and deeply grooved medially. The teeth and basal membrane are colorless in freshly killed individuals. The radular formula from a typical specimen is 129 x 42. 1. 42. An average dental row consists of a dwarf but robust rachidian tooth with a blunt cusp (Fig. 4a) flanked on each side by a series of unicuspidate lateral teeth that very gradually increase in size outward (Figs. 4b,c,d). The inner laterals bear a linear series of 6 to 8 denticles on the outer sides of the cusps and fewer on the inner. The denticles decrease in number outward and become obsolete at about the level of the 30th tooth. The outermost laterals are smooth hamate hooks with elongated bases.

White, stellate spicules of two principal size classes were found imbedded in the

---

Figures 1-5. *Chromodoris fayeae*. 1. Dorsal aspect of animal in life. 2. Anteroventral aspect of animal in life: a. oral tentacle; b. mouth; c. upper foot lip; d. lower foot lip; e. foot; f. hyponotum. 3. Elements of the labial armature: a. top view of exposed portion of elements *in situ;* b. lateral view of three typical elements freed from matrix. 4. Representative teeth from left side of 60th row of radula: a. rachidian; b. 1st lateral; c. 2nd lateral; d. outermost tooth (42nd). 5. Representative spicules from innermost layers of notal epidermal tissue; the two size classes are illustrated.

inner epidermal layers of the notum in freshly killed specimens (Fig. 5). They were concentrated in a loose band circumscribing the margins of the body cavity. The larger elements attained a maximum diameter of 140μ while the smaller were about half that size.

No trace of a penial armature was found.

Distribution. — This species has been taken on the open Pacific coast of mainland Mexico and from several localities within the Gulf of California: (1) Bahía San Luis Gonzaga, 23 September 1962, 1 specimen; (2) Isla Ángel de la Guarda, 1957, 7 specimens; (3) Isla Santa Cruz, 26 June 1964, 9 specimens; (4) Mazatlán (yacht club cove), 20 December 1961, 2 specimens; (5) Santa Cruz, Nayarit (type locality), 6 March 1966, 4 specimens; 4 February 1967, 16 specimens; (6) Tentacatita, Jalisco, 6 February 1963, 1 specimen. Vertical distribution of the animals ranged from lower intertidal to 37 feet.

Name. — The specific patronym *fayeae* was chosen to honor Faye B. Howard, Research Associate in Conchology, Santa Barbara Museum of Natural History, in recognition of her many outstanding contributions to our knowledge of Panamic mollusks.

Discussion. — Following the opinions of Odhner (1957: 250-253), Gohar and Aboul-Ela (1957: 204), Marcus and Marcus (1960: 901), Burn (1962: 152), Farmer (1963: 81) and Marcus and Burch (1965: 247-248), I reject the generic name *Glossodoris* Ehrenberg, 1831, in favor of *Chromodoris* Alder and Hancock, 1855, for species of Chromodoridinae with unicuspidate lateral teeth, and *Hypselodoris* Stimpson, 1855, for those bearing bicuspidate ones. This choice is necessary because the radula of Ehrenberg's *Glossodoris* has never been examined. For a review of this controversy see Odhner (1957).

According to these views the present species must be assigned to *Chromodoris* on the basis of its gross morphology, dwarf rachidian, and unicuspidate radular teeth. Marcus (1965: 272-273) observed that elements of the labial armature, which generally consist of rodlets, either simple or terminating in a bifid hook, or are scale-like platelets, are of taxonomic significance in the Chromodoridinae. Thus, the flexed rodlets with terminal bifid hooks of the present species further substantiate its generic assignment.

This is the third endemic chromodorid described from the Panamic region.

Family Gymnodorididae

Nembrotha hubbsi sp. nov.

(Plate 1)

Type material. — Holotype: California Academy of Sciences, Department of Invertebrate Zoology no. 315. Collected 21 April 1962 at a depth of 10 m near Isla la Ventana, Bahía de Los Ángeles, Baja California, Mexico; 28°55′N., 113°32′W. Paratypes: California Academy of Sciences, Department of Invertebrate Zoology no. 316 (one specimen); Santa Barbara Museum of Natural History no. 23705 (one specimen). Collecting data for paratypes same as holotype.

Description. — Dimensions of actively crawling individuals observed by Farmer and Sloan were: length, 38, 32, 21, 25, 19 mm; width, 9, 9, 4, 4, 3 mm; height, 11, 11, 3.5, 6, 4 mm, respectively. However, one preserved specimen from Isla la Ventana measured 54 mm in length, indicating that live animals may grow to be at least 60-70 mm long.

The general body shape is limaciform, rounded in front, highest in the cardiac region and tapering to a pointed tail. The surface is smooth, not furnished with tubercles, papillae, or extra-branchial processes. The head region is provided with a vestigial frontal veil which passes around the anterolateral corners and becomes obsolete at about the level of the rhinophores. Distinct pallial ridges are not present.

The striking coloration of this species at once separates it from all other northeastern Pacific nudibranchs. The background color is a deep yellow ochre. Five longi-

tudinal cerulean blue stripes of varying width, bordered on each side by a narrow line of intense blue-black or black, occur on each side of the body and extend for most of the length. A similar stripe arises medially in the head region, passes back between the rhinophores, is interrupted in the branchial region, and continues posteriorly. Most of the lines converge on the tip of the tail. The inner surfaces of the branchiae are dark blue-black; their outer faces a deep yellow ochre with a blue line running up the primary stem. The rhinophores are dark blue-black. The general color pattern is retained after five years in 70 per cent alcohol.

The prominent rhinophores are perfoliate and retractile within chambers bearing low, smooth, upstanding sheaths. The number of rhinophoral lamellae was not determined.

There is a circlet of 5 branchiae located medially on the posterior slope of the cardiac hump. As in other gymnodorids, the branchiae are not retractile within a subepidermal chamber but are highly contractile. Due to maceration, the configuration of the finer structures of the branchiae could not be determined.

The radular morphology was determined from one of the larger specimens (41 mm preserved). The formula at the level of the 10th row was 35 x 3-4. 1. 1. 1. 3-4. The rachidian teeth (Fig. 6a) consist of thickened arched bases with the extremities derachidians reported for other species of *Nembrotha* (Eales, 1938: 96; Marcus, 1956: 47). veloped into upstanding subequal prongs, and are much more robust than the delicate A well developed central cusp, as in *N. gracilis* Bergh, 1877 (pl. 56) and *N. rubropapulosa* Bergh, 1905 (pl. 18) is lacking in *N. hubbsi*. The prominent first laterals are U-shaped with asymetrical extremities terminating in a pair of long sharp points (Fig. 6b). The outer side of the shoulder bears a grooved process which apparently hinges with the first marginal plate. The 3 to 4 marginal plates are greatly reduced irregular triangles and decrease in size outwards (Fig. 6c, d, e, f). The attached bases of the rachidians and first laterals, and upper portions of the outer marginal plates are a dark yellowish-brown; the free portions are colorless. A labial cuticle was not found.

Mr. Farmer (personal communication) has observed this species swimming in an aquarium by undulating its body from side to side in a manner similar to that of *Flabellinopsis iodinia* (Cooper, 1862).

Distribution. — To date this species has been collected only in the northern part of the Gulf of California. Five specimens were obtained by Prof. Hubbs and party from: (1) Isla la Ventana (type locality), 3 specimens; (2) reef betwen Isla la Ventana

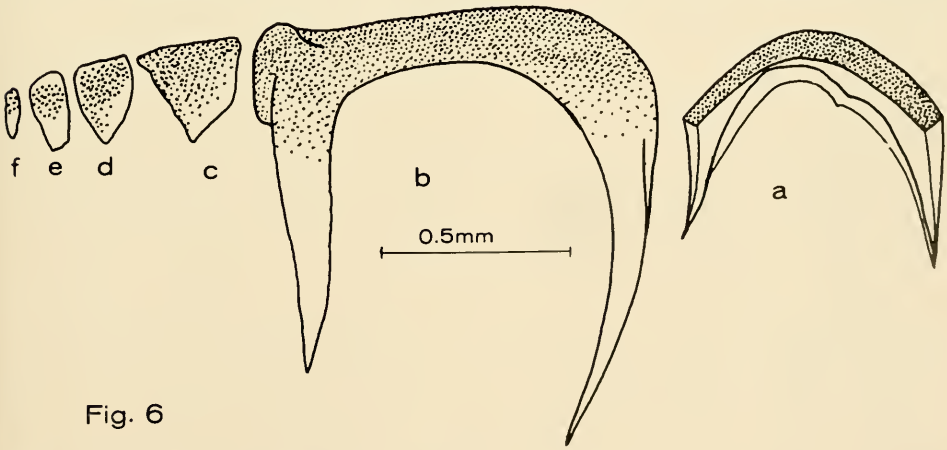

Fig. 6

Figure 6. *Nembrotha hubbsi*. Typical teeth from 10th row of radula: a. rachidian; b. 1st lateral; c-f. marginals.

and Isla Cabeza de Caballo, 1 specimen; (3) Punta Que Malo, 1 specimen. All localities are within Bahía de los Angeles. Additional material was collected by Wesley Farmer and John Sloan in May, 1962, and March, 1963, at Isla Cerralvo, Bahía de los Ángeles, and Puerto Refugio on Isla Ángel de la Guarda. I have also tentatively identified this species from color motion pictures taken in the La Paz area during a recent California Academy of Sciences expedition to the Gulf of California.

Name. — The specific name *hubbsi* was chosen to honor Prof. Carl L. Hubbs of the Scripps Institution of Oceanography, who first brought this elegent animal to my attention.

Discussion. — Bergh (1877) erected the genus *Nembrotha* to accommodate a number of colorful, limaciform gymnodorids from the western Pacific, principally the Philippine Sea. This genus differs from the related *Gymnodoris* Stimpson, 1855 (= *Trevelyana* Keelart, 1858) by possessing rachidian teeth, reduced number of laterals, fewer gills, and absence of a prostatic portion of the vas deferens. This last character, however, applies only at the specific level as a prostate has been demonstrated to occur in *N. lineolata* (see Eales, 1938: 97) and *N. nigerrima* (see Macnae, 1957: 361).

Burn (1962: 98) erected *Tambja* for those species of *Nembrotha* bearing a rachidian tooth in the form of a simple rectangular plate, bifid first lateral, a highly reduced number (3 to 4) of marginal teeth, and a pair of short extra-branchial processes. This last character, however, is neither figured nor described for *Tambja sagamiana* (= *N. sagamiana* Baba, 1955) contrary to Burn's (*loc. cit.*) statement.

The radula of *N. hubbsi* is most similar to that of *N. gracilis* Bergh, 1877 (pl. 56) and *N. rubropapulosa* Bergh, 1905 (pl. 18), but may be readily distinguished by the different configuration of the rachidian, lateral, and marginal teeth. Also, the color pattern is entirely different. Until a comprehensive review of the genus is undertaken, I prefer to assign the present species to *Nembrotha* (*sensu lato*). This species is the first eastern Pacific representative of this colorful tropical genus.

Family Onchidorididae

Acanthodoris stohleri sp. nov.

(Plate 2)

Type material. — Holotype: California Academy of Sciences, Department of Invertebrate Zoology no. 307. Paratype: no. 308 at the same institution. Both specimens collected at Bahía San Luis Gonzaga (inner side of Isla Willard), Baja California, Mexico (20° 48′N., 114° 25′W.) on 5 February 1966 by Mr. Gale Sphon.

Description. — The largest specimen obtained from all collections measured, in life, 21 mm long and 11 mm broad. Average individuals were smaller: 14.5 mm long and 7.5 mm broad.

The body is typically acanthodoridiform; subovate, broader in front than behind (Fig. 7). The mid-dorsal region is somewhat arched and bordered all around by a wide, flat notal brim. A moderate number of upstanding, slender papillae, more or less equidistant from each other, cover the notum except around the margin. Although taller and shorter ones are intermingled, the latter occur more abundantly toward the margins. In the color plate, the papillae are highly contracted.

The color pattern immediately distinguishes *A. stohleri* from all other described acanthodorids. In gross dorsal aspect, the notum is black with a wide, cherry-red margin. The notal papillae, rhinophore sheaths and rhinophores are of a similar but more intense shade of red. In detail the rhinophores are tipped distally with a highly contrasting yellowish-white pigment that also occurs sparingly as flecks on some of the notal papillae, branchiae, oral veil, at the junction of the foot and hyponotum, and on the notal surface. The foot is mostly colorless except for a few longitudinal streaks of black and red pigment. In most specimens the base of each papilla is surrounded by a colorless halo. Considerable variation in intensity and relative abundance of the pigments were

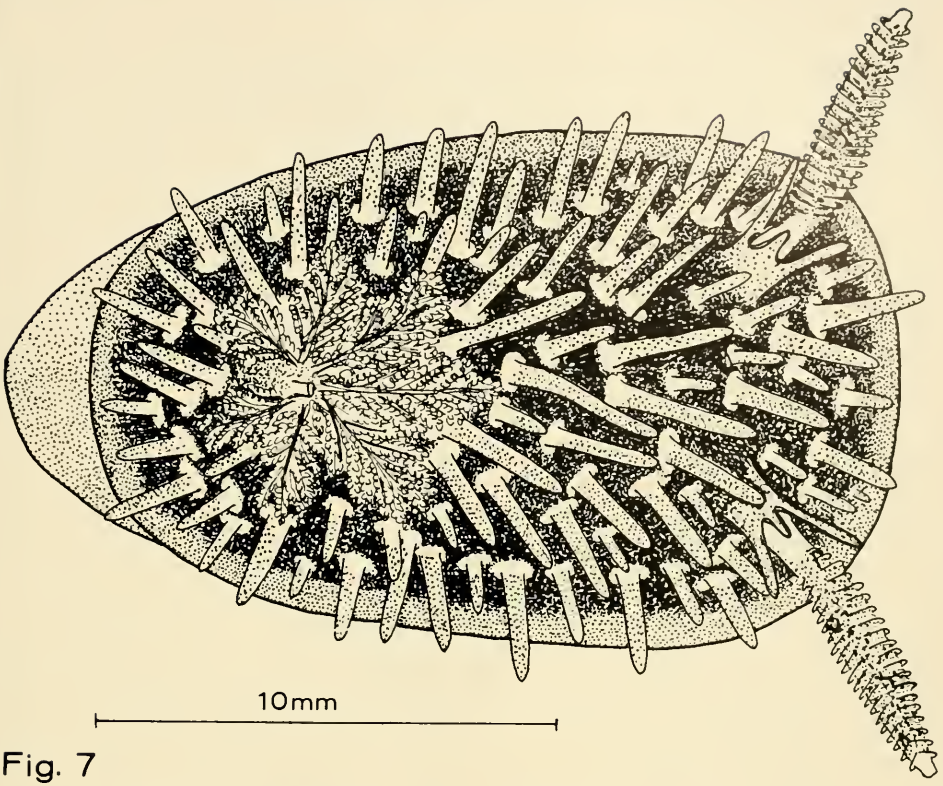

Fig. 7

Figure 7. *Acanthodoris stohleri.* Dorsal aspect of animal in life.

observed but the over-all pattern and basic colors were constant. Specimens preserved one year in 70 per cent isopropyl alcohol retained most of the black and red pigments.

In ventral aspects (Fig. 8) the foot is about two-thirds the width of the notum and protrudes posteriorly as a rounded, flat tail. Its anterior margin is weakly bilabiate with the upper lip barely discernible (Fig. 8c). The margins are entire, not notched. The broad head region is produced into a semicircular veil with unilabiate margins and is very slightly wider than the greatest width of the foot (Fig. 8b). The anterolateral corners are expanded into blunt triangles.

As in other members of the genus, the retractile rhinophores are elongate and deeply perfoliate. In life they are directed forward and outward. About two-thirds of the length of each rhinophore is occupied by the conspicuous club, which bears 18 to 22 transverse lamellae joined anteriorly by a longitudinal septum. The rhinophore stalks are slightly inflated at their bases and the entire organs are capable of being retracted within upstanding sheaths which usually bear 1 to 4 elongate papillae similar in shape and length to those on the notum. Each rhinophore terminates distally in a knob free of lamellae.

The 6 to 7 bipinnate branchiae are separate at their bases and are contractile, but not retractile, within a subnotal chamber. They decrease in size posteriorly. Conspicuous white globular glands occur within the bases of the primary branchial stems. Unlike other acanthodorids for which data are available, the present species does not bear notal papillae within the area circumscribed by the branchial circlet. The anal opening occurs atop a conspicuous excretory papilla within the branchial arc. Under ten power magnification, rhythmically beating cillia may be observed on the inner distal face of the anal tube.

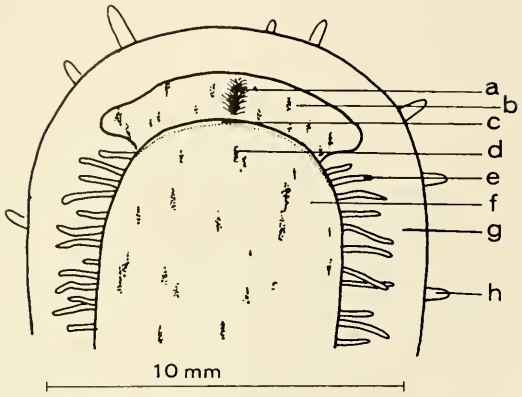

Fig. 8

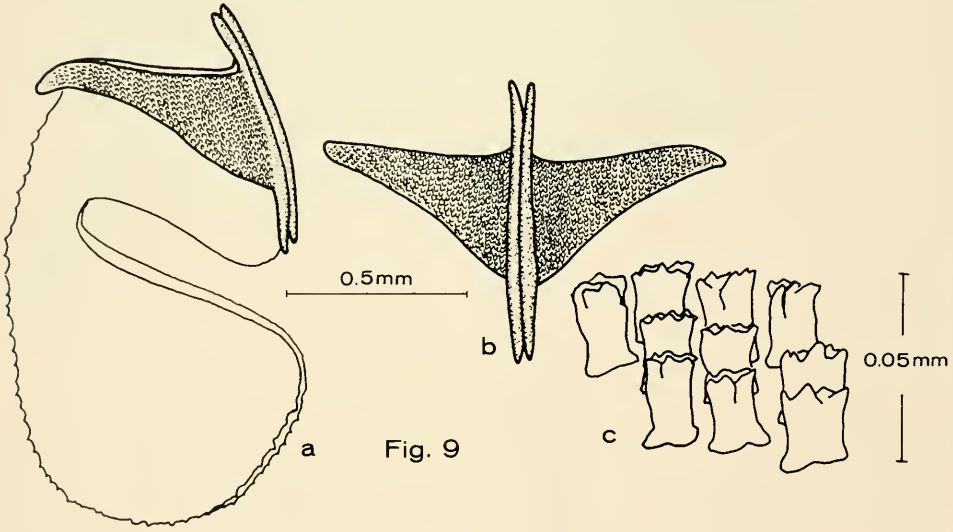

Fig. 9

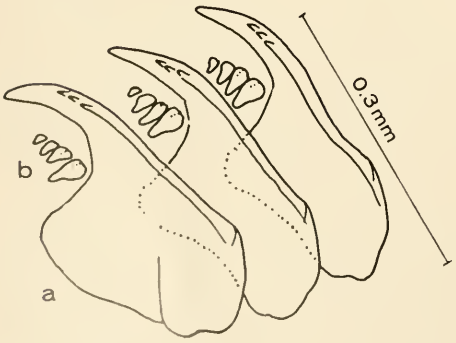

Fig. 10

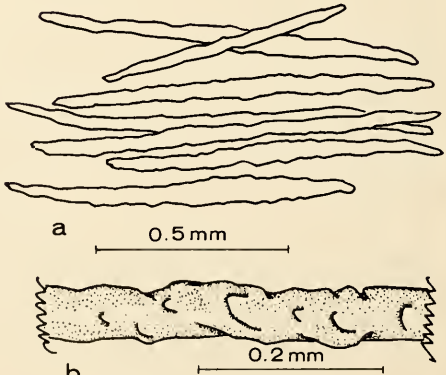

Fig. 11

The labial disc is characteristic in shape, cuticular and mostly transparent (Fig. 9a). In a 14 mm specimen it measured 1.5 mm long. The margin joining the two halves is serrate. The upper portion of each component gives rise to a triangular area supported along its median margin by an elongated chitinous rod (Figs. 9a, b). The triangles are composed of rows of minute, horn-colored elements with bluntly denticulate distal margins (Fig. 9c). Each element is attached to the basement membrane by an imbedded, thickened base.

The radula is narrow, colorless, and 2 mm long in an average live specimen of 14 mm. The formula is 34 x 4. 1. 0. 1. 4. The denticulation is similar to that of other acanthodorids: the first lateral is a large, erect hamate hook arising from a thickened base and bears 2 to 3 inconspicuous denticles about half way along the cusp (Fig. 10a). The four marginals (Fig. 10b) are wedge-shaped, greatly reduced, and decrease in size outwards.

The spicules, although few in number, are relatively large, attaining a length of 1.0 mm in a 14 mm live specimen. They are simple, thick rods with slightly nodulose surfaces and tapering ends and occur singly, not forming bundles or a reticulum (Fig. 11a, b). The greatest concentration is radially oriented around the notal margins, but they do not attain the edge thus leaving the brim free (Fig. 8e). Similar but smaller spicules are found scattered in the mid-dorsal integument and rhinophore bases.

The penis bears a series of spines, but details of the armature and other aspects of the reproductive system have not been determined.

Several individuals of the large collection made at Punta Diggs on 12 February 1967, and transported to Scripps Institution of Oceanography, deposited nidosomes (egg masses) on the aquarium walls within a few days after capture. Apparently the animals were undergoing a spawning cycle since many individuals were in a coital position when collected. Nidosomes, presumably belonging to this species, were common under or near stones harboring the nudibranchs. No evidence of reproductive activity of specimens collected during other seasons has been observed either in the field or in the aquarium.

The nidosome, as in many doridiform nudibranchs assumes the shape of a white ribbon, loosely coiled counterclockwise, attached by one edge to the substratum. The attached and free margins are of equal length resulting in erect, vertical sides. In general shape it resembles that of *Acanthodoris nanaimoensis* as figured by Hurst (1967: 257) except, curiously, her illustration depicts a dextrally-oriented spiral.

Of the nine nidosomes deposited, the simplest consisted of a single convolution, the largest of approximately two whorls. The pure white egg capsules contained a single egg each and were deposited in vertical rows within the colorless, jelly-like matrix. A typical nidosome measured 9 mm at its greatest diameter and 2.8 mm in height. No attempt was made to observe embryological development.

Distribution. — This species has been collected only within a very restricted geographical area along the northeastern shores of the Baja peninsula: (1) Bahía Percebú (about 15 miles south of San Felipe), 12 February 1965, 9 specimens; 26 November 1965, 1 specimen; (2) Punta Diggs, 12 February 1967, 37 specimens (egg masses present); (3) Puertecitos, 26 November 1964, 3 specimens, 19 March 1965, 7 speci-

Figures 8-11. *Acanthodoris stohleri.* 8. Anteroventral aspect of animal in life: a. mouth; b. oral veil; c. anterior foot margin; d. pigment streak; e. spicule (imbedded in hyponotum); f. foot; g. hyponotum; h. dorsal papilla. 9. Labial armature and elements: a. lateral aspect of the paired membranous plates; b. frontal view of primary supporting ribs and attached triangular basis anchoring labial elements; c. detail of elements. 10. Three half-rows from middle of radula: a. denticulate first lateral; b. the four successive marginals. 11. Spiculation: a. spicules from notal margain; b. detail of spicule surface.

mens (egg masses present); (4) Bahía San Luis Gonzaga (type locality), 5 February 1966, 3 specimens. All animals occurred under stones in the lower intertidal region.

Name. — The specific name *stohleri* was chosen to honor Dr. Rudolf Stohler of the University of California at Berkeley, in recognition of his indefatigable efforts in developing the journal "The Veliger" into one of the major international publications in malacology.

Discussion. — *Acanthodoris* Gray, 1850, is distinguished from the related suctorian phanerobranch genera *Akiodoris* Bergh, 1879, *Adalaria* Bergh, 1878, and *Onchidoris* Blainville, 1816, by the presence of numerous soft notal papillae, a body broader in front than behind, elongate rhinophores, upstanding papillated rhinophore sheaths, and a characteristic radula. Only the first two genera bear an armed penis.

In addition to its unique color pattern, *Acanthodoris stohleri* may be distinguished from other members of the genus by the absence of notal papillae within the branchial circlet, and the presence, on the rhinophore sheath margins, of papillae similar to those on the notum.

Acanthodoris stohleri is the first named subtropical representative of this common temperate and subarctic genus.

Acknowledgments

I am grateful to the San Diego Natural History Museum and the Santa Barbara Museum of Natural History for the many courtesies extended to me, and to Faye B. Howard, Gale G. Sphon, Fay Henry Wolfson, Allan J. Sloan, and Helen Dushane for providing me with specimens and distributional data. I would especially like to thank Wesley M. Farmer for his data on the new species of *Nembrotha*. The San Diego Society of Natural History kindly provided me with facilities at the Vermilion Sea Field Station and funds for the color plate, so expertly executed by Dr. and Mrs. G Dallas Hanna and Maurice Giles of the California Academy of Sciences.

Sumario

Las recientes colecciones de moluscos Opistobranquios obtenidas en las zonas de mareas del Golfo de California, comprenden varios Nudibranquios nuevos. Hasta la fecha, se habian observado en las zonas cálidas del Pacífico oriental, solamente 29 especies correspondientes a estos animales sin concha; de modo que estas colecciones indican, que dichas poblaciones son más abundantes y diversas, por lo menos en la parte septentrional de la provincia Panámica. En el presente trabajo se describen tres especies nuevas de Nudibranquios.

1. *Chromodoris fayeae* sp. nov. Dórido grande, blanco, con bordes de tonalidades brillantes en rojo y amarillo. Se han observado estos animales en muchas localidades del Golfo de California. Se trata del tercer Chromodórido descripto, que es endémico en la región Panámica.
2. *Nembrotha hubbsi* sp. nov. Animales de color brillante, ocre amarillento con listas azules. Su distribución abarca por lo menos las regiones septentrionales y meriodionales del Golfo, Esta especie viene a ser la primera que representa este género tropical de vivos colores, en el Pacífico oriental.
3. *Acanthodoris stohleri* sp. nov. Dórido pequeno, negruzco, con el borde del dorso de color rojo. Se encontró solamente en una zona restringida (entre Bahía Percebu y Bahía San Luís Gonzaga) en las costas nordeste del Golfo. Se trata del primer representante subtropical de un género que es común en las zonas templadas y subárticas.

Literature Cited

Baba, K.
1955. Opisthobranchia of Sagami Bay: Supplement. Iwanami Shoten, Tokyo. 194 p; 20 pls.; 56 text figs.

Bergh, L. S. R.
1877 Malakologische Untersuchungen; *in* C. Semper: Reisen im Archipel der Philippinen 11: 429-[illegible] pls. 54-57.

1878. *Ibid.*, 14: 603-645; pls. 66-68.
1879. Gattung nordischer Doriden. Arch. Naturgesch., 45 (1): 354.
1879. On the nudibranchiate gasteropod Mollusca of the North Pacific ocean, with special reference to those of Alaska. Proc. Acad. Nat. Sci. Philadelphia 31: 71-132; pls. 1-8.
1880. On the nudibranchiate gasteropod Mollusca . . . Part II. Proc. Acad. Nat. Sci. Philadelphia 32: 40-127; pls. 9-16.
1905. Die Opisthobranchiata. Siboga Reports 50: 1-248; pls. 1-20.

BLAINVILLE, H. M. D.
1816. Prodome d'une nouvelle distribution systematique du règne animal. Bull. Soc. Philom., Paris (unpaginated).

BURN, R.
1962. Descriptions of Victorian nudibranchiate Mollusca, with a comprehensive review of the Eolidacea. Mem. Nat. Mus. Melbourne No. 25: 95-128; figs. 1-24.

COOPER, J. G.
1862. Some genera and species of California Mollusca. Proc. Calif. Acad. Nat. Sci., 2: 202-207.

EALES, B.
1938. A systematic and anatomical account of the Opisthobranchia. John Murray Exped. Sci. Rep., 5 (4): 77-122; figs. 1-28; pl. 1.

EHRENBERG, C. G.
1831. Symbolae Physicae animalia evertebrata exclusis Insectis. Berlin. (Not seen).

ELIOT, C. E.
1904. On some nudibranchs from East Africa and Zanzibar. Pt. 4. Proc. Zool. Soc. London 1 (2): 380-406; pls. 23-24.

FARMER, W. M.
1963. Two new opisthobranch mollusks from Baja California. Trans. San Diego Soc. Nat. Hist., 13 (6): 81-84; fig. 1; pl. 1.

GOHAR, H. A. F., and I. A. ABOUL-ELA
1957. The development of three chromodorids. Publ. Mar. Bio. Sta. Al-Ghardaqa Red Sea. No. 9: 203-228; pls. 1-5.

GRAY, J. E.
1850. Figures of molluscan animals. *In* Guide to the systematic distribution of Mollusca in the British Museum. Pt. 1. London, 1857. (Not seen).

HURST, A.
1967. The egg masses and veligers of thirty northeast Pacific opisthobranchs. Veliger 9 (3): 255-287; figs. 1-31; pls. 26-38.

KEELART, F. E.
1858. Description of a new Ceylonese nudibranch. Ann. Mag. Nat. Hist., 3 (1): 257.

KEEN, A. M.
1958. Sea shells of tropical west America. Stanford Univ. Press, Stanford, Calif. xi+624 pp.; illus.

MACNAE, W.
1957. The families Polyceridae and Goniodorididae (Mollusca, Nudibranchiata) in southern Africa. Trans. Roy. Soc. South Africa 35 (4): 341-372; pls. 17-18.

MARCUS, ERNST
1956. Notes on Opisthobranchia. Bol. Inst. Oceanografico 7 (1-2) 31-79; pls. 1-8 (published 1958).
1965. Some Opisthobranchia from Micronesia. Malacologia 3 (2): 263-286; figs. 1-43.

MARCUS, ERNST, and J. B. BURCH
1965. Marine euthyneuran Gastropoda from Eniwetok atoll, western Pacific. Malacologia 3 (2): 235-262; figs. 1-43.

MARCUS, ERNST, and EVELINE MARCUS
1960. Opisthobranchia aus dem Roten Meer and von den Malediven. Akad. Wiss. Lit. Mainz, Math. Natur. Kl., 1959 (12): 871-934; figs. 1-86.

ODHNER, N. H. J.
1939. Opisthobranchiate Mollusca from the western and northern coast of Norway. Kg. Norske Vidensk. Selsk. Skr., No. 1: 1-93; figs. 1-59.
1957. *Chromodoris* contra *Glossodoris*. A systematic controversy. Proc. Malacol. Soc. London 32 (6): 250-253.

STIMPSON, W.
1855. Descriptions of some of the new marine Invertebrata from the Chinese and Japanese Seas. Proc. Acad. Nat. Sci. Philadelphia 7: 378-389.

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THERMAL RELATIONS, DISTRIBUTION, AND HABITAT OF *CNEMIDOPHORUS LABIALIS* (SAURIA: TEIIDAE)

DENNIS L. BOSTIC

TRANSACTIONS

OF THE SAN DIEGO
SOCIETY OF
NATURAL HISTORY

VOL. 15, NO. 3, 5 JUNE 1968

THERMAL RELATIONS, DISTRIBUTION, AND HABITAT OF *CNEMIDOPHORUS LABIALIS* (SAURIA: TEIIDAE)

Dennis L. Bostic

Abstract. *Cnemidophorus labialis*, a lizard endemic to Baja California, Mexico, was studied in 1966 and 1967. This species inhabits a narrow coastal strip of Sonoran Desert from Punta San Jose south to Miller's landing, an area subject to frequent northwest winds, fog, predominantly winter rainfall, and summer temperatures similar to those of San Diego, California. It is usually encountered in areas of sparse but varied vegetation and well-drained soil. Its range may be restricted by the occurrence of *C. hyperythrus*. The normal activity range (NAR) of *C. labialis* is 30- 42C. Its mean body temperature is 37.2C, nearly 1C lower than any previously reported for *Cnemidophorus*. The small size and low body temperature of this lizard may reflect thermal adaptation to its coastal habitat. There were no statistically significant differences between the MBTs of males and females, or of adults and immatures; nor were their important seasonal or daily variations. Body temperatures were more closely correlated with substrate than air temperatures. Diurnal activity began between 0800 and 1000 and at soil temperatures of 32C; peak activity occurred between 1000 and 1300. Completely overcast skies, strong steady winds, and prolonged precipitation interrupted activity. Adults enter hibernation from late July through September, immatures in December. Active individuals were first observed in March.

Resumen. *Cnemidophorus labialis*, lagarto endémico de Baja California, México, ha sido estudiado durante 1966 y 1967. Esta especie habita una estrecha banda costera del desierto de Sonora, desde Punta San José en el Sur, hasta el desembarco de Miller (Miller's Landing); en una zona afectada por vientos frecuentes del Noroeste, nieblas, lluvias invernales dominantes, y temperaturas estivales similares a las de San Diego, California. Estos animales se encuentran usualmente en regiones de escasa, pero variada vegetación y en terrenos con buén drenaje. Su distribución está posiblemente restringida por la presencia de *C. hyperythrus*. La amplitud normal de actividad (NAR) de *C. labialis* abarca de los 30°C a los 40°C. La temperatura media del cuerpo es de 37.2°C, casi un grado menos que las observadas previamente para *Cnemidophorus*. La talla pequeña de este lagarto y la temperatura baja del cuerpo podián indicar una adaptación térmica a su habitat costero. No se presentan diferencias de significado estadístico, en la temperatura media del cuerpo (MBT) de machos y hembras, o entre individuos adultos y jóvenes; ni tampoco variaciones importantes, ya sea estacionales o diarias. La temperatura del cuerpo podria relacionarse más directamente con la temperatura del substrato que con la del aire. La actividad diurna se inicia entre las 0800 y 1000 horas, cuando la temperatura del suelo es de 32°C; y la máxima actividad entre las 1000 a las 13000 horas. La actividad de estos animales se interrumpe cuando el cielo está cubierto, y con vientos y precipitaciones fuertes y persistentes. Los adultos entran en hibernación de finales de Julio a Septiembre, y los jóvenes en Diciembre. En Marzo empiezan a observarse individuos en actividad.

Cowles and Bogert (1944) and Bogert (1949) pointed out that diurnal species of lizards maintain body temperatures at characteristic levels relatively independent of air and substratum temperatures primarily by behavioral means, and that the ability to maintain these temperatures is essential for survival. They demonstrated that species in the same genus have similar body temperatures even though they exist in markedly different environments and, conversely, that lizards of different genera maintain different temperature levels although they occur within the same habitat. Interpretations of these

species differences, and temperature responses of reptiles in general, have been reviewed from historical, behavioral, ecological and physiological standpoints by Schmidt-Nielsen and Dawson (1964).

The present study was undertaken to determine the thermal relations of *Cnemidophorus labialis* (Baja California Striped Whiptail). *C. labialis,* endemic to Baja California, Mexico, is the only member of the sexlineatus species group inhabiting the peninsula, and because it inhabits a relatively inaccessible strip of coastline it is the least known member of the group. During this study additional data on the distribution and habitat of *C. labialis* were gathered.

Methods

During the spring, summer, and fall of 1966 and 1967, the body temperatures (BT's) of 150 *C. labialis* were recorded in the field, and under a variety of ambient conditions, throughout much of the species' known range in Baja California Del Norte, Mexico. Individuals were collected by shooting them with six-inch rubber bands. A Schultheiss rapid equilibrium thermometer was used to record BT's. The thermometer was inserted at least one centimeter into the lizard's cloaca within five seconds after capture, and was read (to the nearest 0.2C) when the mercury column reached equilibrium. When recording BT's, I wore a cloth glove to minimize heat conduction to or from my hand. BT's were not taken for lizards which had been chased, showed evidence of internal bleeding, were mutilated, or showed abnormal behavioral patterns due to the observer's presence.

Other temperatures usually recorded at the site of capture were air temperature (4-5mm above substratum) and substral temperature (3mm beneath the surface). The bulb of the thermometer was shaded for air temperature readings. Soil temperature above 50C was recorded as 50C +. Additional data frequently recorded for each capture included time (Standard), per cent cloud cover, wind velocity (Beaufort wind scale), sex, snout-vent length (SVL), and behavior of lizard prior to capture (*e.g.* basking, foraging).

The more important terms as summarized by Brattstrom (1965) and used throughout this paper are: *voluntary minimum* (theoretically the lowest body temperature voluntarily tolerated; in practice, the lowest body temperature recorded of an active individual); *voluntary maximum* (theoretically the highest body temperature voluntarily tolerated; in practice, the highest recorded body temperature of an active individual); *normal activity range* (the range of body temperatures from the voluntary minimum to the voluntary maximum); *basking range* (the range of body temperatures within the normal activity range for basking individuals); *mean body temperature* (the mean of body temperatures within the normal activity range).

The term "significant" is used throughout to denote a statistical difference at the 95% confidence level. All mean body temperatures (MBT's) have been rounded off to the nearest 0.1C.

Distribution

Based on data furnished by Belding, collector of the type series of *C. labialis,* Stejegner (1890) recorded the type locality as Cerros (= Cedros) Island. However, *C. labialis* has not subsequently been collected on Cedros, despite several visits by herpetologists; and Savage (1954) suggests that the type specimens were collected at Bahía San Quintin on the peninsular mainland, where Belding also collected. If Savage is correct, the only published localities for *C. labialis* are Arroyo Seco (Bostic, 1966a), Bahía San Quintin (Burt, 1931; Tevis, 1944; Walker, 1966; Lowe, Wright and Norris,

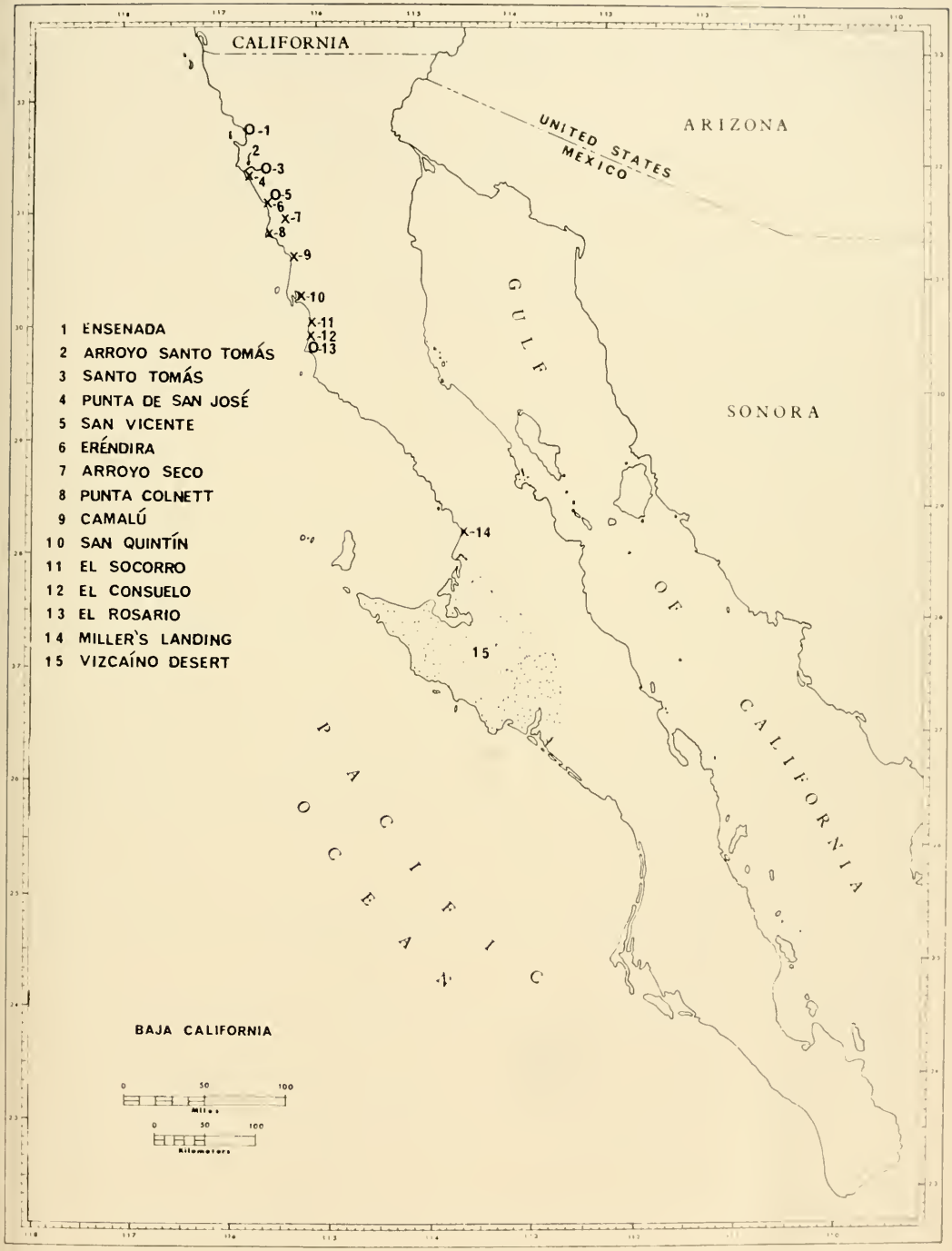

Figure 1. The recorded distribution of *Cnemidophorus labialis* in Baja California, Mexico. Collecting sites and general localities are indicated by X and O, respectively.

1966), Socorro (Murray, 1955; Lowe *et al.*, 1966; El Consuelo (Walker, 1966) and Miller's Landing (Tevis, 1944; Duellman and Zweifel, 1962; Lowe *et al.*, 1966) (Fig. 1). I have also collected specimens at Punta San José, Erendira, Punta Colnett, Camulú, and Socorro (Fig. 1).

All collecting localities, excluding Miller's Landing and El Consuelo, fall within the vegetative parameter Shreve (1936) termed the Chaparral — Sonoran ecotone (the region between Arroyo Santo Tomás and 20 miles north of El Rosario). If the ecotone is not delimited, this area (based on the dominant forms and composition of the flora and fauna) is Sonoran Desert (Short and Crossin, 1967). Miller's Landing and El Consuelo occur within the Central Desert phytogeographic area (Wiggins, 1960), and Shreve's and Wiggins' (1964) "*Agave-Fransceria*" Region. The dominant coastal vegetation, several species of *Agave, Fransceria chenopodifolia, Yucca valida, Opuntia cholla* and *Dudleya spp.*, is sparse and widely spaced (Wiggins, 1960).

Punta San José, approximately seven miles south of the Arroyo Santo Tomás, is the northernmost recorded locality for *C. labialis*. This general area probably represents the true northern limit for the species. Farther north, the coastal terrain is rugged and mountainous, in direct contrast to the flat coastal terraces and plains to the south that are inhabited by whiptails.

Arroyo Seco, (approximately ten miles from the coast) is the most inland capture locality for *C. labialis*. This area is on the fringe of the coastal cloud cover and fog. I suspect that the eastern and southern distributional limits of *C. labialis* probably conform to coastal areas subject to much fog, frequent northwest winds, predominately winter (November to April) rainfall distribution, and a summer temperature similar to that of San Diego, California. These environmental conditions, excluding precipitation distribution, prevail along the west coast of Baja California as far south as the Magdalena Plains (Aschmann, 1959).

I consider the environmental conditions that occur throughout the recorded range of *C. labialis* suboptimal for *C. hyperythrus*, the only other small *Cnemidophorus* with which it is sympatric. *C. hyperythrus* is most frequently observed in the coastal foothill region, where the duration and intensity of solar radiation is greater, and the frequency and duration of coastal cloud cover and fog less. In the narrow belt of sympatry these species are regularly observed, but in disproportionate numbers. For example, at Camalú only five of the 150 *Cnemidophorus* collected were *C. hyperythrus*. At Arroyo Seco, the habitat preferences of the two species differed. *C. labialis* occupied only the sandy fringe of the coastal sage-scrub community preferred by *C. hyperythrus*, and was most commonly collected in the bordering, sandy-bottomed arroyo where *C. hyperythrus* was absent. *C. hyperythrus* was present in the surrounding areas of *Agave* and gravelly soil, but *C. labialis* was absent.

The southernmost capture locality, Miller's Landing, is 185 mies south of El Consuelo. Duellman and Zweifel (1962) stated that this distribution gap is undoubtedly related to the course of the main road which turns inland at Socorro (11 miles N. of El Consuelo) and does not closely approach the coast to the south until Miller's Landing. The southernmost known locality of *C. labialis* coincides with the northern limit of the Vizcaino Desert (Fig. 1). Here, through the Magdalena Plains region, coastal precipitation is not predictable, and is primarily a summer (May to October) phenomenon (Aschmann, 1959). The presence of *C. hyperythrus* in this area may also affect the southward spread of *C. labialis*, but this is still unstudied.

Habitat

Sand dunes (Tevis, 1944), a sandy plain with scattered *Agave* (Murray, 1955), and a humid coastal prairie (Walker, 1966) have been recorded as habitats for

C. labialis. During 1963-64, I found *C. labialis* abundant at Arroyo Seco (a wide sandy-bottomed river bed) and in the bordering coastal sage-scrub community. Following the torrential rains of 1965 and the concomitant flooding of the arroyo, the population was considerably reduced. The dominant plants of the river bed were *Pluchea sericea*, *Juncus* sp., and *Franseria chenopodifolia*. Less conspicuous plants included *Eriogonum* spp., *Isomeris arborea* and *Mesembrianthemum chrystalinum*. *C. labialis* was frequently observed in or near *Mesembrianthemum* at most collecting localities. In sandy soils of the coastal areas *Mesembrianthemum* appeared to be perennial.

C. labialis was present, though scarce, on gravelly and sandy substrata at the coastal terrace sites of Punta de San José, Erendira, Punta Colnett, and El Socorro (Fig. 1). The dominant vegetation at these localities included *Agave shawii* and *Euphorbia misera*. Also present but less conspicuous were *Rosa minutiflora*, *Atriplex* sp., *Opuntia* sp., *Machaerocereus gummosus*, *Myrtillocactus cochal*, *Dudleya* spp., *Mesembrianthemum*, and numerous annuals.

At Camulú, an agricultural community on the Llano de Hamulú, whiptails are unusually abundant. This nearly flat plain borders the Pacific for approximately 30 miles from near San Telmo to Santo Domingo, and is delimited a few miles inland by the foothills of the interior mountains. The soil is fine and compacted, but well drained. *Franseria chenopodifolia* and *Agave shawii* are the dominant plants. Less conspicuous were *Euphorbia misera*, *Opuntia serpentina*, *O. echinocarpa*, *Mammilaria dioca*, *Bergerocactus emoryi*, *Myrtillocactus cochal*, *Mesembrianthemum*, and *Atriplex* sp.

C. labialis exhibited a clumped pattern of local distribution at all collecting sites. This was particularly evident at Camalú and Arroyo Seco, where the majority of collecting occurred. A similar pattern of distribution was reported by Tevis (1944) and Walker (1966). It appeared that this pattern was correlated with the availability of suitable egg laying sites (areas covered with a variety of annuals, with light sandy soil exposed to direct solar radiation in the morning and afternoon), and adjacent shrub cover. The vegetational cover was not dense nor unvaried (i.e., predominately *Agave*). Dense cover does not satisfy their thermal requirements and homogeneous vegetation, probably owing to the sparse leaf litter, does not offer a varied food supply. Such sites are relatively sparse, and in the Camulú, Arroyo Seco, and Bahía San Quintin areas are becoming scarcer because of agricultural activity.

Thermal Relations

Temperature Preferences. — The normal activity range (NAR) for *C. labialis* is 30C to 42C (Table 1). This NAR includes the low, often isolated BT's of lizards considered by Cowles and Bogert (1944) to be "basking" in order to resume "normal activity." I consider the "basking range," unless quantitatively measured (basking duration), to be arbitrary (Bostic, 1966b). *C. labialis* was frequently observed foraging at temperatures throughout the NAR. Similarly, lizards which basked for short periods had BTs between 30C - 39C.

The voluntary minimum temperature tolerated is 1-4C lower than those reported by Fitch (1958), Carpenter (1961), McCoy (1965), and Bostic (1966b) for other species of *Cnemidophorus*. These investigators included the low BT's of active individuals in their calculation of the NAR. The voluntary maximum of 42C is similar to those values previously recorded for *Cnemidophorus*.

The previously recorded high and low mean body temperatures of *Cnemidophorus* are 41.3C for *C. tigris* (Bogert, 1949) and 38C for *C. sexlineatus* (Carpenter, 1961), respectively. This variability, in part, reflects the omission of "basking range" BT's from the NAR.

TABLE 1

A Summary of Published Data on Temperature Relations in Cnemidophorus

Species Group	Species	Normal Activity Range (NAR)	$\bar{X} \pm$ SE NAR	N	Critical Thermal Maximum (CTM)	$\bar{X}$ CTM	N	Authority
Lemniscatus	*C. lemniscatus*	34.6-42.3	39.0	31	45.2-46.6	46.2		Brattstrom, 1965
	C. lemniscatus	34.5-41.0	38.5	13				Brattstrom, 1965
Hyperythrus	*C. ceralbensis*	37.4-42.5	40.35	23				Soulé, 1963
	C. hyperythrus beldingi	33.4-42.2	38.5 ± .14	138				Bostic, 1966b
	C. hyperythrus hyperythrus	38.3-46.6	39.9 ± .25	14				Soulé, 1963
Tessellatus	*C. tigris*	37.4-43.5	41.3 ± .24	33				Bogert, 1949
	C. tigris	35.0-44.6	40.4	47				Brattstrom, 1965
	C. tigris					46.0	1	Cole, 1943
	C. tigris septentrionalis	34.0-43.0	39.8	88				McCoy, 1965
Sexlineatus	*C. gularis*	37.8-41.0	38.9	3				Brattstrom, 1965
	C. labialis	30.0-42.0	37.2 ± .26	136				This paper
	C. sexlineatus	32.0-43.0	38.0					Carpenter, 1961
	C. sexlineatus	34.6-41.5	39.5	45				Fitch, 1956
	C. sexlineatus	38.5-43.0	41.0 ± .47					Bogert, 1949
	C. sexlineatus	31.0-44.0	40.0-41.0	100				Fitch, 1958

The MBT of *C. labialis* is 37.2C (SE = 0.201; SD = 2.35), which is 0.8-1.3C lower than the MBT's of other *Cnemidophorus* calculated in a similar manner (see Carpenter, 1961; Bostic, 1966b). This low MBT may reflect thermal adaptation to the fog and cloud shrouded coastal habitat of *C. labialis*. The favorable volume to surface ratio of this small lizard may also aid in thermal adaptation. Walker (1966) reported "that only *C. hyperythrus espiritensis* (maximum SVL 59.5mm) of Isla Espiritu Santo, Gulf of California, is of smaller size than *C. labialis*." However, I examined a male *C. hyperythrus espiritensis* (SDSNH no. 52852) which has a SVL of 64mm.

There was no significant difference between the MBT's of male and female *C. labialis*. The MBT for 77 males and 59 females was respectively 37.2C (SE = 0.255; SD = 2.24) and 37.1C (SE = 0.268; SD = 2.06). Bogert (1949) found no intersexual differences in the MBT's of *C. sexlineatus* or *C. tigris* and Bostic (1966b) found no significant differences in the MBT's of male and female *C. hyperythrus beldingi*. Body temperature variability among species of *Cnemidophorus* is apparently not due to differences in sex.

The MBT of 14 juveniles (SVL < 40mm) is 36.3C (SE = 0.363; SD = 1.36), which is 0.9C lower than that of 37.2C (SE = 0.201; SD = 2.35) recorded for adults. This difference may be biologically important, although it is not statistically significant. The ability of juveniles to function optimally at a lower MBT than adults would be advantageous. Juveniles hatch in August and are active through December, when soil and air temperatures are low; adults begin hibernating in July. The high correlation ($r = +0.85$) between juvenile BT's and soil temperature reported by Hardy (1962) for *C. sexlineatus* suggests such an advantage. Concomitantly, competition between adults

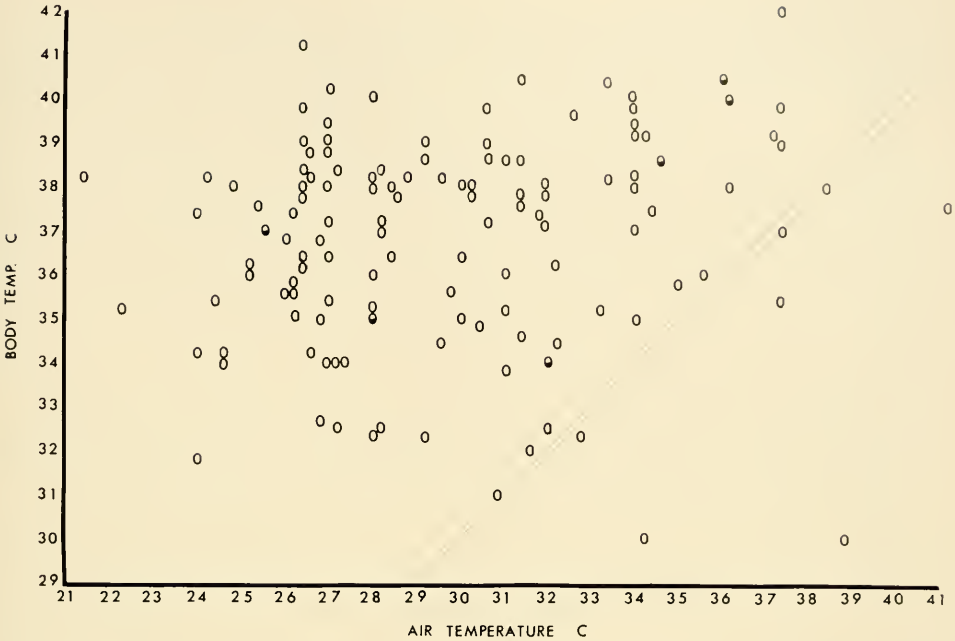

Figure 2. Scatter diagram comparing body temperatures of 135 *Cnemidophorus labialis* with air temperatures 4-5mm. above the substrate. The dashed lines connect the isothermal points. Single individuals are represented by an open circle, and two lizards by half-shaded circles.

and juveniles would be reduced throughout much of their activity seasons since all adults have hibernated by late September. The low MBT would also promote fuller utilization of shaded areas for foraging and protection.

There was no significant difference between morning and afternoon MBT's. The morning series (N = 86) had a MBT of 37.4C (SE = 0.248; SD = 2.30), and the afternoon series (n = 61) a MBT of 37.3C (SE = 0.232; SD = 1.81). I also found no significant monthly differences in body temperatures. Bostic (1966b) reported no seasonal acclimation in *C. h. beldingi.* Bostic (1966b) reported similar findings for *C. h. beldingi.*

Response to Environmental Temperatures. — There is no significant correlation between BT and air temperature (Fig. 2). Only nine lizards possessed BT's within 1C of the air temperature. Seven individuals were recorded with BT's 1-9C less than air temperature, and two lizards maintained BT's 14.8C above air temperature. The majority of whiptails were active at air temperatures ranging from 26C to 32C. No lizards were active at air temperatures above 41C nor below 21C.

There is a closer correlation between BT and substrate temperature (Fig. 3). Below a substrate temperature of 42C the majority of lizards possessed BT's 1-4C above or below the substrate temperature. One lizard maintained a BT 5.4C above that of the substrate. The limit of 50C imposed by using the Schultheiss thermometer to record soil temperatures makes any delineation of the greatest deviation between BT and substrate temperature impossible.

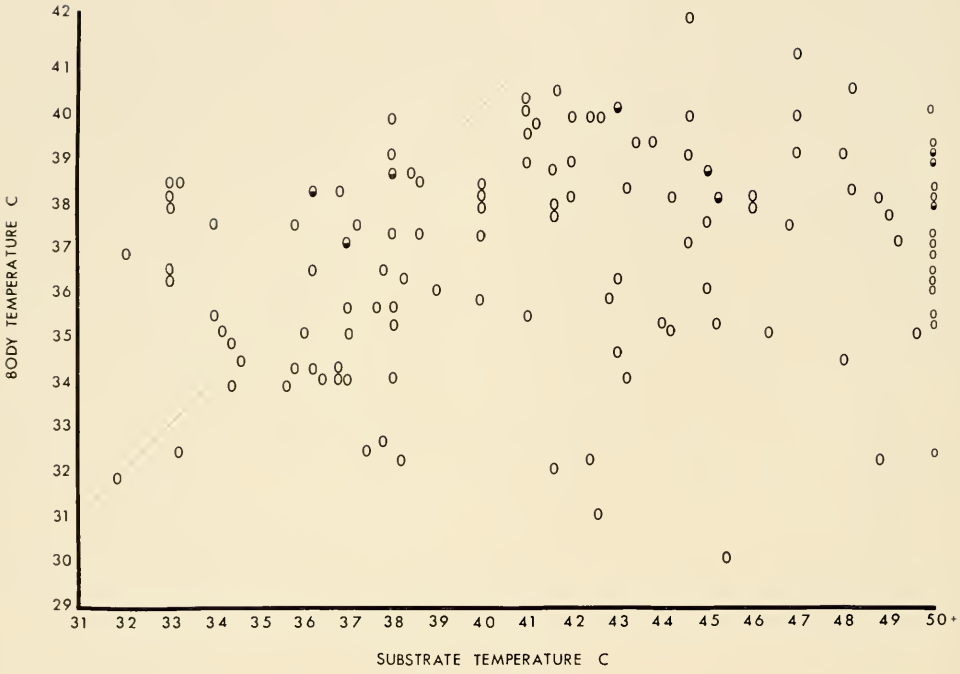

Figure 3. Scatter diagram comparing body temperatures of 134 *Cnemidophorus labialis* with substrate temperatures. The dashed lines connect the isothermal points. Single individuals are represented by an open circle, and two lizards by half-shaded circles.

Daily Activity Cycle. — *C. labialis* commenced activity between 0800 and 1000 at a soil tmperature of about 32C. This initial activity usually coincided with the dissipation of the early morning fog or coastal cloud cover. Milstead (1957), McCoy (1965), Bostic (1966b) and Echternacht (1967) recorded similar emergence times and soil temperatures for other species of *Cnemidophorus*. The major activity peak for *C. labialis* was between 1000 and 1300. This usually coincided with the period between early morning and late afternoon low clouds, wind, and high (50C +) substrate temperatures. No late afternoon activity peak recorded for other species of *Cnemidophorus* by Milstead (1957), Carpenter (1961), Bostic (1966b), and Echternacht (1967) was observed for *C. labialis;* activity virtually ceased at 1500.

As would be expected, the increase in ambient temperatures from spring through summer that occurred in inland areas of the peninsula was not as pronounced along the coast. Subsequently, no obvious seasonal fluctuation in the daily cycle was evident.

The usual daily cycle of *C. labialis* was altered by the varying meteorlogical conditions. Partial cloudiness did not interrupt activity. No lizards, however, were observed on those days that the sun did not shine intermittently. Winds up to seven mph did not seem to adversely affect whiptail activity, and intermittent winds of twelve mph had little affect. Steady winds above 12 mph resulted in the disappearance of most lizards. Whiptails were not active immediately after a prolonged rain, and generally did not resume activity until most of the moisture content in the subsoil had disappeared following one to three days of sun.

Seasonal Activity Cycle. — *C. labialis* was recorded emerging from hibernation in mid-March. Adult whiptails enter into dormancy in the latter part of July, and by late September nearly all adult whiptails have hibernated. All immature whiptails disappeared in late December. A similar pattern of seasonal activity has been reported for *C. h. beldingi* (Bostic, 1966b), and *C. sexlineatus* (Hardy, 1962).

C. labialis collected in March and early April had very small, paired, dull yellow coelomic fat bodies. As the season progressed the coelomic fat bodies became greatly enlarged, and were bright yellow in color. Apparently the differential times of dormancy recorded for whiptails is correlated with the amount of stored fat. A similar pattern of fat storage and utilization was recorded for *C. sexlineatus* (Hardy, 1962; McCoy, 1965) and *C. hyperythrus* (Bostic, 1966b).

ACKNOWLEDGMENTS

I express my appreciation to Mr. Allan J. Sloan and Mr. Wade F. Snyder for their editorial comments and criticisms of the manuscript at various stages of its completion. I am particularly indebted to Mr. William Hite for his frequent assistance in the field and laboratory. In addition, I thank Mr. Sam Angove for his field assistance, Mrs. Aileen Scallet for assistance with the statistical analyses, Mr. Gilbert Voss for assistance in identifying plants, and Mrs. Norrine G. Gearheart for typing the manuscript.

The specimens collected during this study are deposited in the San Diego Natural History Museum.

This study, in part, was made possible by a Sigma Xi Grant-in-Aid of Research to study the testicular histology of *C. labialis*.

LITERATURE CITED

ASCHMANN, N. H.
1959. The central desert of Baja California: Demography and ecology. Univ. Calif. Press, Berkeley and Los Angeles. 315 p.

BOGERT, C. M.
1949. Thermoregulation in reptiles, a factor in evolution. Evolution 3: 195-211.

BOSTIC, D. L.
1966a. Threat behavior in *Cnemidophorus hyperythrus* and *Cnemidophorus labialis*. Herpetologica 22: 77-79.
1966b. Thermoregulation and hibernation of the lizard, *Cnemidophorus hyperythrus beldingi* (Sauria: Teiidae). Southwestern Natur. 11: 275-289.

BRATTSTROM, B. H.
1965. Body temperatures of reptiles. Amer. Mid. Natur. 73: 376-422.

BURT, C. E.
1931. A study of the teiid lizards of the genus *Cnemidophorus* with special reference to their phylogenetic relationships. U. S. Nat. Mus. Bull. 154. 286 p.

CARPENTER, C. C.
1961. Temperature relationships of two Oklahoma lizards. Okla. Acad. Sci. Proc. 41: 72-77.

COLE, L. C.
1943. Experiment on toleration of high temperature in lizards with reference to adaptive coloration. Ecology 24: 94-108.

COWLES, R. B., and C. M. BOGERT
1944. A preliminary study of the thermal requirements of desert reptiles. Amer. Mus. Natur. Hist. Bull. 83: 261-296.

DUELLMAN, W. E., and R. G. ZWEIFEL
1962. A synopsis of lizards of the sexlineatus group (genus *Cnemidophorus*). Amer. Mus. Nat. Hist. Bull. 123: 155-210.

ECHTERNACHT, A. C.
1967. Ecological relationships of two species of the lizard genus *Cnemidophorus* in the Santa Rita Mountains of Arizona. Amer. Mid. Natur. 78: 448-459.

FITCH, H. S.
1956. Temperature responses in free-living amphibians and reptiles of northeastern Kansas. Univ. Kan. Publ. Mus. Nat. Hist. 8: 417-476.
1958. Natural history of the six-lined racerunner (*Cnemidophorus sexlineatus*). Univ. Kan. Publ. Mus. Nat. Hist. 11(2): 11-62.

Hardy, D. F.
1962. Ecology and behavior of the six-lined racerunners, *Cnemidophorus sexlineatus*. Univ. Kan. Sci. Bull. 43: 3-73.

Lowe, C. H., J. W. Wright, and K. S. Norris
1966. Analysis of the herpetofauna of Baja California, Mexico. IV. The Baja California striped whiptail, *Cnemidophorus labialis*, with key to the striped — unspotted whiptails of the southwest. Ariz. Acad. Sci. J. 4: 121-127.

McCoy, C. J.
1965. Life history and ecology of *Cnemidophorus tigris septentrionalis*. Unpub. Ph.D. thesis, Univ. microfilms Inc., Ann Arbor, Michigan. 66-2814. 167 p.

Milstead, W. W.
1957. Some aspects of competition in natural populations of whiptail lizards (genus *Cnemidophorus*). Texas J. Sci. 9: 410-447.

Murray, K. F.
1955. Herpetological collections from Baja California. Herpetologica 11: 33-48.

Savage, J. M.
1954. Notulae herpetologicae 1-7. Kans. Acad. Sci., Trans. 57: 326-334.

Schmidt-Nielsen, K., and W. R. Dawson
1964. Terrestrial animals in dry heat: desert reptiles, p. 467-480. *In* D. B. Dill (ed.), Handbook of Physiology, Vol. 4, Adaptation to the environment. Washington, D.C. Amer. Physiol. Soc.

Short, L. L., Jr., and R. Crossin
1967. Notes on the avifauna of northwestern Baja California. San Diego Soc. Nat. Hist., Trans. 14(20): 281-300.

Shreve, F.
1936. The transition from desert to chaparral in Baja California. Madroño 3: 257-264.

Shreve, F., and I. L. Wiggins
1964. Vegetation and flora of the Sonoran desert. Stanford University Press, 1: 840 p.

Soule, M.
1963. Aspects of thermoregulation in nine species of lizards from Baja California. Copeia (1): 107-115.

Stejneger, L.
1890. Description of a new lizard from Lower California. U. S. Natl. Mus., Proc., 12: 643-644.

Tevis, L., Jr.
1944. Herpetological notes from Lower California. Copeia (1): 6-18.

Walker, J. M.
1966. Morphology, habitat, and behavior of the teiid lizard, *Cnemidophorus labialis*. Copeia (4): 644-650.

Wiggins, I. L.
1960. The origin and relationships of the land flora, p. 148-165. *In* symposium: The biogeography of Baja California and adjacent seas. Syst. Zool. 9 (3-4).

Manuscript Received 10 January 1968

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CASTELA POLYANDRA, A NEW SPECIES IN A NEW SECTION; UNION OF *HOLACANTHA* WITH *CASTELA* (SIMAROUBACEAE)

REID MORAN AND RICHARD FELGER

TRANSACTIONS

OF THE SAN DIEGO
SOCIETY OF
NATURAL HISTORY

VOL. 15, NO. 4, 5 JUNE 1968

Figure 1. Distribution of *Castela polyandra;* the closest (and southernmost) known locality for *C. emoryi* is also shown.

CASTELA POLYANDRA, A NEW SPECIES IN A NEW SECTION; UNION OF *HOLACANTHA* WITH *CASTELA* (SIMAROUBACEAE)

Reid Moran and Richard Felger

Abstract. *Castela polyandra* is a new species of shrub of Isla Tiburón, and of east central Baja California, Mexico. It resembles *Holacantha emoryi* A. Gray in its nearly leafless determinate spinose branches without spur shoots and in its petals, larger in staminate than in pistillate flowers; it differs from *Holacantha* and resembles *Castela* sensu stricto in its 4 (-5)-merous flowers and its deciduous fruits; and it differs from both in having 2-3 times as many stamens as sepals. Since *Holacantha* now seems less distinct than before, it is made a section of *Castela*. The section *Eremacantha* is proposed for *C. polyandra*.

Resumen. *Castela polyandra* es una nueva especie de arbusto de la Isla Tiburón y de la parte centro-oriental de Baja California, México. Se parece a *Holacantha emoryi* A. Gray en tener ramas espinosas casi afilas, sin braquiblastos, y en sus pétalos, los cuales son más grandes en las flores estaminíferas que en las pistiladas. Se diferencia de *Holacantha* y se parece a *Castela* sensu stricto, en que sus flores son tetra- o pentámeras y sus frutos caducos; diferenciándose de ambas por tener doble o triple número de estambres que de pétalos. Como *Holacantha* aparece ahora menos diferenciada, se la incluye en una sección de *Castela*; y se propone la sección *Eremacantha* par *C. polyandra*.

For 37 years botanical collectors in Baja California have been puzzled by a holacanthoid shrub, first found by Professors Ira L. Wiggins and James McMurphy, on the Gulf coastal plain south of Santa Rosalía. Early collectors obtained only sterile plants. In May 1961 Moran got some insect-damaged staminate flowers there; and in August 1964, he found abundant fruiting material at Bahía de los Angeles, some 150 miles to the north-northwest. In late April of 1966 he found both staminate and pistillate flowers at the northern locality. Meanwhile, between 1963 and 1965 Felger made four collections of it, one with flowers, on the east side of Isla Tiburón, Sonora. The accumulated material permits the description of the following new species.

Castela polyandra Moran & Felger, spec. nov.

Frutex dioicus, spinosus, fere nudus, ad 1.7m altus et 4.8m latus. Ramuli rigidi omnesque spinescentes, 3-6mm diametro, hirtelli, glabrati, quisque ramo ramulisque ejusdem anni suis monade determinata simul crescentibus. Folia sparsa, anno primo decidua, subadpresse hirtella, brevipetiolata, laminis ellipticis usque ad cuneatis, rotundatis subtruncatisve, apiculatis, 5-24mm longis, 4-15mm latis. Flores spisse paniculati fasciculative, rubri, 4 (-5)-meri, pedicellis 2-6mm longis; sepala deltoidea, extus hirtella, 1-1½mm longa; petala elliptica, rotundata, glabra, 3-7mm longa, in fl. ♂ quam in fl. ♀ insignite majora; stamina petalis 2-3-plo pluria, filamentis barbatis; pistila 4 (-5), stylis connata. Drupae 1-5, stipitatae, subcarnosae, 11-14mm longae, putamine duro, lenticulare. Chromosomata: n = 13 *Typus: Moran 13072 (SD 62160, 62161).* Holacantho emoryo *plus quam speciebus ceteris* Castelae *ramulis validis spinescentibus subnudis, foliorum axillarium absentia, et florum staminatorum petallis majoribus accedit sed ab illo floribus rubris 4 (-5)-meris fructuque mox deciduo recedit. A speciebus ceteris* Castelae *et a* Holacantho *staminibus petalis 2-3-plo pluribus differt.*

Dense but irregular stiff spiny nearly leafless dioecious shrub (Fig. 2), to 1.7m high and 4.8m wide, various parts at first hirtellous, the trichomes simple, stiff, white,

Figure 2. Shrub of *Castela polyandra* at the type locality, north of the village, Bahía de los Angeles.

to 0.4mm long, mostly ascending to subappressed. Stems usually several from the base, crooked, sympodial, mostly to ca. 5cm thick, rarely the main trunk to 18cm thick, the lower branches sometimes prostrate and 3½m long, not rooting; bark gray, mostly smooth but on largest stems coarsely flaking; branches at first gray-green, densely ascending- to spreading-hirtellous, next season yellow-green and glabrous, 3-6mm thick, usually slightly flattened in the plane of the nearest branchlet; branch systems of one season from upper axils, ½-3 (-7)dm long, ½-2 (-4)dm wide, the axis somewhat zigzag, ending in a stout spine, with internodes ca. 1-4cm long, all but the lower 1-4 and the upper 1-5 nodes with stiff divaricate or upcurved branchlets that rebranch 0-2 times in the same manner, the branchlets of whatever order each slightly flattened at the base in the plane of the mother axis and each ending in a stout spine. Leaves falling the first season, subappressed-hirtellous, short-petiolate, the blade elliptic to cuneate, rounded to subtruncate, apiculate, 5-24mm long, 4-15mm wide, thickish, with ca. 4 pairs of obscure ascending lateral veins. Inflorescence axillary, a compact panicle to 1cm long or reduced to one or a few fascicles sometimes of 10 or more flowers; bracts deltoid, ca. ½mm long, densely hirtellous; pedicels 2-6mm long, red, hirtellous but sparsely so by anthesis; buds globose to obovoid, the sepals open except in the smallest buds, the petals imbricate. Flowers (Fig. 3) in April to July, red, 8-14mm wide; sepals 4 (-5), red, deltoid-ovate, acute, 1-1½mm long, hirtellous but by anthesis nearly glabrate except on the margins, persistent in fruit; petals 4 (-5), free, spreading, red, ovate to obovate, rounded, cupped, 3-7mm long, 2-4mm wide, glabrous; stamens 8-12 (-14-15?), 4 (-5) antesepalous and 4-8 (-10?) epipetalous, in one circle outside the glandular disk, the filaments bearded ventrally with stiff white trichomes ca. 0.5-0.7mm long; glandular disk yellow, 1½-2mm wide, crenulate opposite the filaments. Pistillate flowers 8-11mm wide; petals 3-4½mm long, 2-2½mm wide; stamens reduced, ca. 1½mm long; disk

Figure 3. Flowers of *Castela polyandra* (*Moran 13072*), × 6½: left, staminate; right, pistillate.

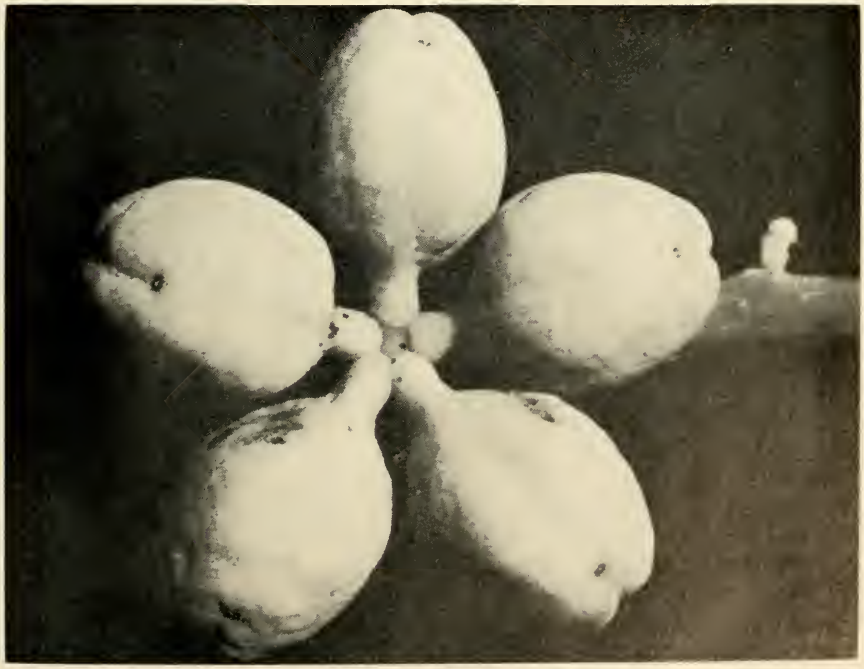

Figure 4. Fruit of *Castela polyandra* (*Moran 11895*), × 3. Usually the drupes are four or fewer.

ca. 2mm wide; gynoecium 2½-3mm high, 2-3½mm wide, the pistils 4 (-5), connate by the styles, the ovaries free, semiovoid, 1½-2mm high, each with one axillary ovule, the styles ca. ½mm long, the stigmas spreading, 1½-2mm long, ca. ½mm wide, papillose. Staminate flowers 11-14mm wide; petals 5-7mm long, 3-4mm wide; filaments erect, 2-3mm long, 0.5-0.8mm wide at the base and tapering evenly, bearded ventrally in the lower half, the anthers yellow, oblong, sagittate, 2½-3mm long, ca. 1mm wide, the basal lobes ca. ¾mm long; disk ca. 1½mm wide, concave; gynoecium vestigial or mostly absent. Fruits (Fig. 4) in August, solitary or sometimes 2-4 in subumbellate clusters, falling within a few months; drupes 1-4 (-5), stipitate, pale orange or drying red, 11-14mm long, the stipe 2-2½mm long and 2½-3mm thick, the body 9-12mm long, 9-10mm wide, 6-8mm thick, the exocarp fleshy, bitter, the putamen stony, light tan, lenticular with obtuse to rounded margins, 6-9mm wide, 4-5mm thick. Gametic chromosome number: $n = 13$.

Holotype. — On gravelly east slope at 75 meters elevation, 3 miles north of the village of Bahía de los Angeles, on the road to La Gringa, Baja California, Mexico (near 28° 59′N, 113° 35½′W), 29 April 1966, *Moran 13072* (SD 62160, 62161); isotypes (to be distributed): ARIZ, BH, CAS, DS, GH, ICF, K, LAM, LL, MEXU, MICH, NY, RSA, UC, US.

Distribution. — (Fig. 1.) Locally common on bajadas within 10 miles of the Gulf of California and below 150 meters elevation in central Baja California and on the east side of Isla Tiburón, Sonora, Mexico. Other collections: Baja California: type locality, 25 August 1964 [fruiting], *Moran 11895* (to be distributed: ARIZ, CAS, DS, ICF, LAM, MEXU, RSA, SD, UC, US); mesa 6 miles south of Santa Rosalía, 8 August 1964 [fruiting], *Lindsay 1994* (DS); arid slopes 7 miles south of Santa Rosalía, 8 April 1963 [sterile], *Wiggins & Wiggins 18214* (DS); field at Hacienda San Bruno, 10 March 1935 [sterile], *Wiggins 7952* (DS); rocky outwash plain, San Bruno, 23 November 1938 [sterile], *Gentry 4058* (ARIZ, DS, UC), 18 April 1939 [sterile], *Gentry 4462* (DS); 3 miles south of San Bruno, 13 March 1934 [sterile], *Ferris 9036* (DS); bajada 5 miles south of San Bruno, 2 December 1946 [sterile], *Wiggins 11510* (DS); 17 miles north of Mulegé, 26 October 1964 [sterile], *Hastings & Turner 64-400* (ARIZ); 10 miles south of San Bruno, 25m, 24 May 1961 [staminate], *Moran 8465* (BH, CAS, DS, ICF, MEXU, SD, UC, US); canyon above gypsum village, Isla San Marcos, 22 April 1952 [sterile], *Lindsay 2210* (DS). Isla Tiburón, Sonora: coarse gravelly soil of bajada ca. 1 mile inland, near Santa Rosa, 5m, 26 October 1963 [sterile], *Felger 9359* (ARIZ, LAM, SD); coarse gravelly soil of bajada ca. 1 mile inland, near Palo Fierro (= Punta Tortuga), 10m, 2 May 1964 [sterile], *Felger 10011* (ARIZ, LAM, SD), 18 July 1964 [staminate], *Felger 10135A* (ARIZ, LAM, SD), [pistillate] *10135B* (ARIZ), 15 February 1965 [sterile], *Felger 12557* (ARIZ, LAM, SD).

Castela polyandra has been found only within about 10 miles of the Gulf of California and almost exclusively on east sloping bajadas. Of the dozen localities cited, only that on Isla San Marcos apparently is not on an east slope. Despite considerable collecting in coastal Sonora, the plant has so far been found there only on the east side of Isla Tiburón, which has the only extensive east-sloping bajadas close to the east shore of the Gulf. Also, several Seri Indians have told Felger that they do not know of it on the mainland. They do distinguish between, and give different but related names to, *C. polyandra* and the somewhat similar *Holacantha emoryi* A. Gray, which occurs nearby on the mainland (Fig. 1).

Several plants otherwise confined to Baja California and its islands occur on one or more of the Sonoran islands but apparently not on the mainland. Besides *C. polyandra*, those of Isla Tiburón include *Camissonia angelorum* (S. Wats.) Raven, *Cassia confinis* Greene, *Drymaria holosteoides* Benth., and *Pluchea trifida* S. Wats.

The two known areas for *C. polyandra* on the east coast of Baja California are nearly 150 miles apart, but the plant is not necessarily absent between: the intervening coast is mainly roadless and little visited and its flora little known.

At the type locality, *C. polyandra* grows in gravelly granitic soil of the narrow bajada, one of the dominant shrubs in an open stand with *Fouquieria diguetii* (van Tiegh.) I. M. Jtn., *F. splendens* Engelm., *Olneya tesota* A. Gray, *Larrea divaricata* Cav., and *Jatropha cuneata* Wigg. & Roll., above the zone of *Frankenia palmeri* S. Wats. On the east side of Isla Tiburón, it is limited to an open area of the ecotone between the lower bajada vegetation, where *Frankenia palmeri* is dominant, and the middle bajada vegetation, where *Larrea divaricata* and other desert shrubs are dominant. Common shrubs with the *Castela* include *Phaulothamnus spinescens* A. Gray, *Olneya tesota*, *Krameria grayi* Rose & Painter, *Condalia globosa* I. M. Jtn., *Zizyphus lycioides* A. Gray, and *Lycium* spp.

At the type locality in May, Moran spent several hours looking for flowers. Although he examined perhaps several hundred shrubs, only a few of these — probably less than five per cent — bore any buds or flowers; and usually there were few per plant, mostly on only one or two branches. (Flowering branches commonly were on the south side of the plant.) To judge from the several sterile collections, flowering apparently is uncommon and irregular in spring. On Isla Tiburón in July, just after the onset of the summer rains, Felger found many of the shrubs in full flower; flowers were abundant in the center of the shrub, where rabbits could not reach them.

Dr. Marion S. Cave kindly made chromosome counts from two collections of *C. polyandra* (*Moran 8465*, *13072*) and for each reports a gametic number of $n = 13$.

At each of our localities, plants of *C. polyandra* at flowering time are infested with small caterpillars, which festoon the flowering branches with spidery webs and spoil the flowers for botanical specimens. At Bahía de los Angeles in December 1967, Moran found numerous larvae of assorted sizes, as well as pupae and one adult. Larvae were eating leaves and bark. Similar infestations occur on *C. peninsularis* Rose on the southern islands of the Gulf of California and on *Holacantha emoryi* A. Gray at least in western Imperial County, California. Larvae from Bahía de los Angeles and from Imperial County, raised by Dr. John A. Comstock and Mr. Charles F. Harbison, proved to be *Atteva exquisita* Busck. Adults of this moth had previously been taken by Mr. Harbison on San Francisco Island, where *C. peninsularis* occurs, and at Bahía de los Angeles. Powell, Comstock, and Harbison (Ms.) report on the development of this moth. Similar insect damage was noted in specimens of *C. tortuosa* Liebm. and *C. tweedii* Planch., but the insects are not known.

Relationships

In the treatment of Engler (1931), the new species can go only in the subtribe Castelinae, comprising the genera *Castela* Turp. and *Holacantha* A. Gray, though it does not quite fit the description of the subtribe. It approaches both these genera but does not quite fit in either as defined, for example, by Engler or by Cronquist (1944b).

Vegetatively, the new species resembles *Holacantha* more than it does *Castela* sensu stricto. Since every stem apex becomes a spine, new shoots must be lateral, and growth is thus sympodial. Each new shoot is a determinate system of two to four generations of axes, evidently all developing at once rather than the main axis first and the branches later. The branches mostly are rather stout and more or less elongate, with several evident nodes; and although the ultimate ones are reduced, they are not clearly differentiated from the others as short slender spines. Although leaves in the new species are as large as in several species of *Castela* and may persist for several months, there are no spur shoots with later leaves, and the general aspect of the shrub is almost as bare as in *Holacantha*.

In *Castela* sensu stricto the branching pattern varies widely from one species to another and considerably within certain species. (For some species it is difficult to generalize from the few terminal branches seen in herbaria; and we have seen no material of *C. depressa* Turp.). In *C. spinosa* Cronq. and in some specimens of *C. erecta* Turp. and *C. tortuosa* Liebm., as in *Holacantha* and the new species, all branches (not including spur shoots) are spine-tipped; and the complex branch system, with three to five generations of axes, evidently develops as one unit rather than the main axis first and the branches later. In other specimens of *C. erecta* and *C. tortuosa*, the branch system is reduced to a main axis with short and often slender axillary spines, and the tip of the main axis is less uniformly spinose. These three species of *Castela*, in contrast with *Holacantha* and the new species, produce additional foliage leaves like the primary ones but on accessory spur shoots.

In other species of *Castela* likewise, the tips of the main branches are less regularly spinose, though they often are subspinose or abortive. Growth often appears to be sympodial and in some species probably is uniformly so; but from herbarium specimens it is not clear that it is so in all species. In *C. peninsularis* Rose, the main axis regularly bears spinose primary and secondary and sometimes also tertiary branches. In *C. calcicola* (Britt. & Small) Ekman, *C. coccinea* Griseb., and *C. jacquinifolia* (Small) Ekman, spinose primary and secondary branches are sometimes present. In each of the other species that we have seen, axillary spines are present in at least some specimens; but there is no indication of unit development of more complex branch systems. In all these species except *C. jacquinifolia*, axillary leaves were seen in at least some specimens; it is not clear whether they would always be present on some older branches.

Thus in its branching pattern and in its stout and nearly leafless branches, the new species resembles *Holacantha* more closely than it does any species of *Castela* sensu stricto. From those species of *Castela* which it otherwise most closely resembles in branching pattern, it differs, as does *Holacantha*, in the lack of spur shoots. On the other hand, the flowers are primarily 4-merous and infrequently 5-merous; the few leaves present are relatively large, and some of them persist for several months; and the fruits are shed promptly: in these respects it resembles *Castela*. In plants of the type collection, flowering under perhaps less than ideal conditions, the inflorescence is reduced, as usual in *Castela*; but in those from Isla Tiburón, that flowered at the onset of the summer rains, it is stouter and more like that of *Holacantha*.

Raven (1967) reported a somatic chromosome number of $2n=26$ for a cultivated plant of *H. emoryi*, originally from Maricopa County, Arizona. For a collection (*Moran 13138*) from 6½ miles southeast of Coyote Wells, Imperial County, California, Dr. Cave reports a gametic number of $n=13$. Thus *H. emoryi* has the same chromosome number as reported above for *C. polyandra*. Apparently there are no reports for *Castela* sensu stricto.

With respect to petal size, greater in staminate than in pistillate flowers, the new species resembles *H. emoryi* and seems to differ from other members of both genera. Apparently in *H. stewartii* C. H. Muller and so far as we can discover in other species of *Castela*, there is no such size difference.

With respect to stamen number, varying from twice to thrice the number of sepals but commonly falling between, the new species differs both from *Castela* sensu stricto and from *Holacantha* and indeed from most other Simaroubaceae. Although *Holacantha* and perhaps some other species of *Castela* have some tendency to anisomery, apparently in those species the stamens are rarely more than twice as many as the sepals.

Although *Holacantha* has always been treated as a genus separate from *Castela*, the question of where to place the new species has led us to consider its status more closely. In some respects the new species resembles *Castela* sensu stricto and in others *Holacantha*. Thus, *Holacantha* does not now appear as distinct as it did. But the new species also

differs from both. It cannot be placed in either group without broadening the definition of the group while at the same time somewhat reducing the distinction of the two; yet, it is so obviously similar to both that there is no question of establishing a new genus for it. For these reasons, we think it best to reduce *Holacantha* to a section of *Castela* and to place the new species in a separate section. We define *Castela* and its sections as follows.

CASTELA Turp., Ann. Mus. Paris 7: 78, 1806. (Nom. conserv.)

Dioecious shrubs or small trees, mostly with some spinose branchlets, some with all branches spinose. Leaves alternate, scattered on the main branches or crowded on spur shoots, simple, entire or toothed, thick, mostly less than 5cm long, sometimes scalelike, caducous or mostly persistent. Inflorescence axillary or supra-axillary, a panicle or raceme of cymules or individual flowers or reduced commonly to one or a few fascicles or even to one flower. Flowers 4-8-merous; sepals 4-8, small, deltoid, persistent; petals as many, several times larger, imbricate in bud, deciduous; stamens mostly twice to thrice as many, inserted around a glandular disk; pistils mostly as many as the sepals, each with one ovule, separate below, united by the styles, the stigmas separate. Fruit of separate drupes, deciduous or persisting for several years.

KEY TO SECTIONS:

Flowers 4 (-5)-merous; fruits soon deciduous; inflorescence less than 2cm long; leaves with well-developed blades, mostly persistent.

Stamens twice as many as the sepals; petals not larger in the staminate flowers; branches spinose or not, leafy; spur shoots commonly present. 1. *Castela*

Stamens twice to thrice as many as the sepals, the number varying in the same inflorescence; petals larger in the staminate flowers; branches all spinose, sparsely leafy; spur shoots absent. 2. *Eremacantha*

Flowers (5-) 6-8-merous; fruits persistent for several years; inflorescence 2-10cm long; adult leaves scalelike, soon deciduous; branches all spinose; spur shoots absent. 3. *Holacantha*

Castela section *Castela*

Neocastela Small, N. Am. Fl. 25: 230, 1911.

Castelaria Small, loc. cit.

Main axes abortive and subspinose or in some apparently indeterminate, the primary (to tertiary) branches commonly spinose and often reduced to axillary spines; less commonly all branches spinose. Leaves with well-developed blades, persistent, the primary ones scattered but similar ones commonly produced later on spur shoots, the shrub thus leafy. Inflorescence a small panicle or raceme with the axis slender and rarely 1cm long, or commonly reduced to a fascicle or even to one flower. Flowers 4 (-5)-merous; petals apparently the same size in staminate and pistillate flowers; stamens normally twice as many as the sepals. Drupes sessile by a narrow base or commonly stipitate, soon deciduous.

TYPE SPECIES: *C. depressa* Turp.

In the latest revision, Cronquist (1944a) recognized 12 species, extending from Texas to Argentina and from the Galapagos Islands to the Antilles.

Castela section *Eremacantha* Moran & Felger, sect. nov.

Ramuli spinescentes, quisque ramo ramulisque ejusdem anni suis monade determinata simul crescentibus. Flores 4 (-5)-meri, staminibus sepalis 2-3-plo pluribus. Drupae stipitatae, mox deciduae. Typus: C. polyandra.

Branches all spinose, the branch system determinate, with 2-4 generations of axes developing as a unit; spur shoots none. Leaves with well-developed blades, persistent for

several months but sparsely distributed. Inflorescence a compact panicle, with the axis stout but rarely 1cm long, or reduced to one or a few fascicles. Flowers 4 (-5)-merous; petals larger in staminate than in pistillate flowers; stamens twice to thrice as many as the sepals. Drupes stipitate, soon deciduous.

Type Species: *C. polyandra* Moran & Felger.

The name *Eremacantha* is from Greek words for desert and shrub.

Castela section *Holacantha* (A. Gray) Moran & Felger, stat. nov.

Holacantha A. Gray, Pl. Thurb. 310, 1854.

Branches all spinose, the branch system determinate, with 2-4 generations of axes developing as a unit; spur shoots none. Adult leaves reduced, soon deciduous, the shrub thus essentially leafless. Inflorescence an open to rather crowded panicle, the branches stout, like the vegetative branches, the axis 2-10cm long. Flowers (5-) 6-8-merous, tending to be anisomerous; petals of staminate flowers the same size as or larger than those of pistillate flowers; stamens twice as many as the sepals or fewer than twice as many. Drupes sessile by a broad base, persistent for several years.

Type Species: *Holacantha emoryi* A. Gray.

The section consists of the following two species, native in the southwestern United States and northern Mexico.

Castela emoryi (A. Gray) Moran & Felger, comb. nov.

Holacantha emoryi A. Gray, Pl. Thurb. 310, 1854.

Castela stewartii (C. H. Muller) Moran & Felger, comb. nov.

Holacantha stewartii C. H. Muller, Madroño 6: 131, 1941.

Acknowledgements

We are grateful to the curators of the herbaria at the Arnold Arboretum, the New York Botanical Garden, and the United States National Museum, for the loan of specimens. We are indebted to Dr. Marion S. Cave for the chromosome counts, to Miss Gayle Culver for the map and the drawings, and to Drs. Peter H. Raven and Ira L. Wiggins for critically reviewing the manuscript. Last but not least, we sincerely thank each other for help and encouragement during the preparation of this paper.

Literature Cited

Cronquist, A.
1944a. Studies in the Simaroubaceae, I. The genus *Castela*. J. Arnold. Arb. 25: 122-128.
1944b. Studies in the Simaroubaceae, IV. Resumé of the American species. Brittonia 5: 128-147.

Engler, A.
1931. Simarubaceae, p. 359-405. *In* Engler, A., and H. Harms, Die natürlichen Pflanzenfamilien. 2 ed. Vol. 19a.

Powell, J., J. A. Comstock, and C. F. Harbison
Ms. Biology, life history, and geographic distribution of *Attera exquisita* (Lepidoptera: Yponomeutidae).

Raven, P.
1967. *Holacantha emoryi* Gray. *In* Anon., Documented chromosome numbers of plants. Madroño 19: 134-136.

Accepted for Publication 11 April 1968.

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RECENT DATA ON SUMMER BIRDS OF THE CHIRICAHUA MOUNTAINS AREA, SOUTHEASTERN ARIZONA

J. DAVID LIGON AND RUSSELL P. BALDA

TRANSACTIONS

OF THE SAN DIEGO
SOCIETY OF
NATURAL HISTORY

VOL. 15, NO. 5, 5 JUNE 1968

RECENT DATA ON SUMMER BIRDS OF THE CHIRICAHUA MOUNTAINS AREA, SOUTHEASTERN ARIZONA

J. David Ligon and Russell P. Balda

Abstract. Over four breeding seasons 167 species of birds were recorded from the Chiricahua Mountains and adjacent areas; 19 of these were winter residents or migrants not seen after May. The status of several species apparently has changed since the study of Tanner and Hardy (1958). The Golden Eagle (*Aquila chrysaetos*) and Prairie Falcon (*Falco mexicanus*) appear to have decreased, whereas the Harlequin Quail (*Cyrtonyx montezumae*) and several of the hummingbirds apparently are more common than previously. Several cavity-nesting species appear to have increased in numbers and the Eastern Bluebird (*Sialia sialis*) has become established as a breeding species since 1960. Black Swifts (*Cypseloides niger*), a species for which there is no specimen for Arizona, were seen on one occasion, and a female Lucifer Hummingbird (*Calothorax lucifer*), another unexpected species, was seen on several occasions.

Resumen. Se observaron 167 especies de aves en las Montañas Chiricahua y zonas adyacentes, durante las cuatro estaciones de cria; 19 de estas especies eran residentes invernales o aves migratorias que no aparecian después de Mayo. El estado de varias especies ha cambiado aparentemente desde los estudios realizados por Tanner y Hardy (1958). El Aguila Real (*Aquila chrysaetos*) y el Halcón Café (*Falco mexicanus*) han disminuido, mientras que la Codorniz dedilarga (*Cyrtonyx montezuma*) y varios colibrís son probablemente más abundantes ahora que antes. Varias especies de las que anidan en cavidades han incrementando en número, así, el Azul de tempestad (*Sialia sialis*) aparece bién establecido, de modo que cria en esta zona desde 1960. El Vencejo negro (*Cypseloides niger*) no se ha registrado en Arizona, y solamente se ha visto en una ocasión en esta región, así como una hembra del Colibrí Chupamirto morada grande (*Calothorax lucifer*) otra de las especies raras en esta zona, en donde solo ha sido observado en pocas ocasiones.

The Chiricahua Mountains of Cochise County, Arizona, are located near the Arizona-New Mexico boundary about 20 miles north of the Mexican border. These mountains, along with the Huachuca and Santa Rita mountains, are of special ornithological interest because the northernmost extension of several essentially Mexican species and the southern limit of several boreal forms occur here. This, together with the wide variety of habitats found in the Chiricahuas, ranging from desert scrub to spruce-fir forest, combine to make this region rich in breeding bird species. In recent years the Chiricahuas have become relatively well known to ornithologists, largely because the Southwestern Research Station of the American Museum of Natural History is located in Cave Creek Canyon.

The avifauna of the Chiricahua Mountains has been popularized by a number of ornithologists (Peterson, 1948; Brandt, 1951), but little detailed work has been published. Tanner and Hardy (1958) briefly describe the elevational distribution of some of the more common birds and review the avifaunal studies of the region, pointing out the sparseness of data dealing with breeding birds of the area.

No comprehensive study of plant distribution in the Chiricahuas has been published, but Balda (1967) describes in detail the habitats he studied, and Whittaker and Niering (1965) present an excellent discussion of plant distribution in the nearby and similar Santa Catalina mountains.

We spent a great deal of time in riparian communities, habitats not described by Tanner and Hardy (1958). These are affected by lower temperatures (due to nightly cold air drainage) and higher moisture conditions than the adjacent typical plant communities of a given elevation. Riparian habitat is best developed in canyon bottoms but

is present to some degree wherever permanent or temporary streams are found. Plant species diversity is great in these areas and is reflected in high bird species diversity. Lower elevation riparian woods are characterized by sycamore, willow, cottonwood, maple, walnut, ash, and several species of oaks. The Station is located in such an area. In more restricted canyon bottoms, such as the South Fork of Cave Creek Canyon, many coniferous species typically found at higher elevations are intermingled with the deciduous trees. In the Chiricahua Mountains, Arizona cypress is limited to this community.

Because the avifauna of the Chiricahuas has special interest, we feel that updating the avifaunal list of Tanner and Hardy (1958) is worthwhile, even though an excellent state bird book (Phillips *et al.*, 1964) has recently been published. Our data indicate that dramatic changes in the status of some birds have occurred since Tanner and Hardy's study. Perhaps the best example is the arrival and population increase of the Eastern Bluebird (*Sialia sialis*). In addition, some common species, principally nocturnal ones, were overlooked.

Ligon camped in Cave Creek Canyon from 17 May to 21 July 1964; Balda was at the Southwestern Research Station from 3 June to 2 July of that year. From 17 February to 18 August 1965 Balda conducted a study of the breeding habitats of the birds of the region. Ligon arrived at the Station on 4 May and remained until 5 August. In 1966 Ligon spent three days in Cave Creek Canyon in April and 18 days there in July. He was at the Station for several days during May 1967.

We follow the terminology of Tanner and Hardy (1958) in referring to the status of each species. Species recorded by them for which we have no additional comments are simply listed with a one-word designation of status. More detailed information on abundance is currently being prepared. Those species not recorded by the above authors are indicated by an asterisk; species for which either nests were found or juveniles seen are indicated by a dagger. All specimens were taken by Ligon and are deposited in the collections of The University of Michigan Museum of Zoology. Only species recorded after 1 May are included in this account.

The village of Portal is located below the mouth of Cave Creek Canyon at an elevation of 4770 feet. Paradise is about five miles northwest of Portal. Apache is 12 miles south of Rodeo, New Mexico on U. S. Highway 80. Stewart Forest Camp and Sunny Flats Campground are located in Coronado National Forest between Portal and the Station (elevation 5400 feet); Rustler Park, also in Coronado National Forest, is higher (8400 feet).

SYSTEMATIC LIST

Oxyura jamaicensis, Ruddy Duck*. — A male in breeding plumage was seen on 21 July 1965, in a cattle tank at the foot of the mountains near Portal.

Cathartes aura, Turkey Vulture. — Common. Large flock of about 50 roosted nightly on huge rock above Stewart Forest Camp.

Accipiter gentilis, Goshawk†. — An adult female was collected 5 July 1964, nine miles southwest of Apache. A nest with one flying young was located in the same area the following day at an elevation of about 5200 feet. This nest was about 200 yards downstream from an occupied nest of *A. cooperii*. Goshawks were seen on four occasions over ponderosa pine forest below Rustler Park.

Accipiter striatus, Sharp-shinned Hawk*. — One observed at the station for several days in early May 1965; captured hummingbirds with apparent ease from the station feeders.

Accipiter cooperii, Cooper's Hawk†. — Common in Cave Creek Canyon from oak woodland to spruce-fir forest in 1964 and 1965; seven nests found, four examined, each with four or five eggs or young.

Buteo jamaicensis, Red-tailed Hawk. — Uncommon.

Buteo swainsoni, Swainson's Hawk†. — One seen building a nest 20 May 1964. Nest with two well-grown living young, and a third dead, found 2 July 1964, near Potral.

Buteo albontatus, Zone-tailed Hawk*. — One seen by Ligon perched on rocks in dry South Fork of Cave Creek on 21 May 1964. Two seen by Balda along the South Fork of Cave Creek Canyon in May 1965.

Buteo lagopus, Rough-legged Hawk*. — Winter visitor; last seen on 5 May.

Aquila chrysaetos, Golden Eagle. — Pair seen regularly east of Portal in 1964 and 1965. Not seen in the mountains.

Circus cyaneus, Marsh Hawk*. — One was seen occasionally over the grasslands below Rodeo from March through May 1965.

Falco mexicanus, Prairie Falcon. — Seen irregularly over grassland south of Rodeo and also on west side of the mountains in 1965.

Falco peregrinus, Peregine Falcon*. — Seen regularly in 1964 and 1965 along high cliffs above Stewart Forest Camp and Sunny Flats Campground. Believed to have nested. Ligon observed one drive a Red-tailed Hawk to earth near Sunny Flats Campground.

Falco sparverius, Sparrow Hawk†. — Uncommon. In 1964 a pair nested in a large dead cottonwood one and one-half miles east of Portal. A nest was located near Paradise in 1965. Seen occasionally in ponderosa pine forest.

Callipepla squamata, Scaled Quail†. — Common in grasslands containing a scattering of shrubs along Highway 80 east of the Chiricahuas. Young seen on 8 July 1965. Newly-hatched young captured and photographed on 11 July 1965. A very late nest located on 17 August contained 12 eggs.

Lophortyx gambelii, Gambel's Quail†. — Common in desert scrub surrounding the mountains. Newly-hatched young captured and photographed 9 June 1964.

Cyrtonyx montezumae, Harlequin Quail*†. — Not uncommon but not regularly seen in oak woodland and pine-oak-juniper woodland communities. Four young seen by Balda on 20 July 1965.

Meleagris gallopavo, Turkey†. — Uncommon. Nest, eight eggs located near the Station on 17 May 1965. Seven chicks seen 13 June 1964. Flocks of 8 to 10 birds were seen often in the ponderosa pines below Rustler Park in 1965.

Charadrius vociferus, Killdeer. — Seen irregularly about water tanks.

Actitis macularia, Spotted Sandpiper*. — Five seen on small ponds at the foot of the mountains on 21 July 1965.

Columba fasciata, Band-tailed Pigeon. — Regular in flocks in Cave Creek Canyon in early summer, becoming common to abundant at high elevations in mid-July, when pairs were apparently preparing to nest.

Zenaida asiatica, White-winged Dove†. — Commonly seen from desert scrub up into oak woodland.

Zenaidura macroura, Mourning Dove†. — This species was most common in desert scrub where Balda located 23 nests in 1965. At one nest the young fledged on 4 March. One pair was seen on repeated occasions in ponderosa pine forest.

Columbigallina passerina, Ground Dove*. — One seen by Ligon on 9 June 1964, one and one-half miles east of Portal near a watering tank. Phillips *et al.* (1964: 43) consider the records for the east side of the Chiricahuas as representing strays rather than a breeding population.

Geococcyx californianus, Roadrunner. — Uncommon below Portal.

Otus asio, Screech Owl*†. — Common in Cave Creek Canyon, where nests were found in 1965 and 1967.

Otus trichopsis, Whiskered Owl*†. — Common in Cave Creek Canyon. One or more nests were located near the station in 1964, 1965, 1967.

Otus flammeolus, Flammulated Owl†. — Uncommon. Two nests were located in 1965, each with one young. One nest also contained an addled egg.

Bubo virginianus, Great-horned Owl*. — Uncommon from desert scrub up to the lower edges of ponderosa pine forest.

Glaucidium gnoma, Pygmy Owl*†. — Uncommon. Nest found near the Station on 17 May 1967, in cavity used by Elf Owls the previous two years. Seen and heard occasionally above Rustler Park.

Micrathene whitneyi, Elf Owl*†. — Abundant in Cave Creek Canyon where 20 nests were located by Ligon in 1965.

Speotyto cunicularia, Burrowing Owl*†. — Rare on foothill grasslands surrounding the mountains. One pair nested three miles south of Apache in 1965.

Strix occidentalis, Spotted Owl. — Uncommon. Heard calling in Cave Creek Canyon on 11 July 1964 by Ligon, J. P. Hubbard, and B. K. Harris. One seen at Rustler Park by Balda, 14 August 1965.

Caprimulgus vociferus, Whip-poor-will†. — Common along Cave Creek Canyon floor up to the highest elevations of the mountains. Female with egg ready for laying collected 31 May, 1964.

Phalaenoptilus nuttallii, Poor-will. — Common from desert scrub through oak woodland especially on the drier slopes. Heard primarily at dusk and dawn. Seen foraging about lights at the Station on several occasions.

Chordeiles minor, Common Nighthawk*. — Seen 18 July, 1965, southwest of Apache.

Chordeiles acutipennis, Lesser Nighthawk. — Common on desert scrub surrounding mountain and occasional through oak woodland.

Cypseloides niger, Black Swift*. — Rare. Flock of about a dozen seen above Herb Martyr Dam on 11 July 1964, by Ligon, J. P. Hubbard, and B. K. Harris. They were foraging with Purple Martins, Violet-green Swallows and White-throated Swifts. There is no satisfactory specimen record for Arizona (Phillips *et al.*, 1964: 58).

Aeronautes saxatalis, White-throated Swift. — Common in the mountains. Also foraged over the desert.

Calothorax lucifer, Lucifer Hummingbird*. — Extremely rare. A female was first seen by Balda on 17 June 1965 southwest of Apache in oak woodland adjacent to xeric slopes covered with manzanita and agave. This female was seen again on 26 June and 1 July, and was positively identified at a local rancher's hummingbird feeder. There are only two very old specimen records for the state (Phillips, *et al.*, 1964: 62).

Archilochus alexandri, Black-chinned Hummingbird†. — Uncommon in desert, but very common in oak woodland, riparian canyons and oak-juniper woodland. Occasionally sighted in lower ponderosa pine forest. Fourteen nests were located by Balda in 1965, with extreme dates 15 April to 28 June.

Selasphorus platycercus, Broad-tailed Hummingbird†. — Uncommon in oak woodland and oak-juniper woodland but common in riparian canyon and coniferous forests. An exceptionally early nest found in South Fork on 4 April contained two eggs. Both young fledged by 13 May. The latest nest was located in ponderosa pine forest and contained two young on 1 August.

Selasphorus rufus, Rufous Hummingbird. — Regular from woodlands through coniferous forest from mid-July onward. Seen occasionally in desert as well.

Stellula calliope, Calliope Hummingbird*. — Male shot but not retrieved by Ligon in Rustler Park on 16 July 1964. One seen on 2 August 1965 in ponderosa pine forest.

Eugenes fulgens, Rivoli's Hummingbird. — Regular at station feeders but uncommon in woodland and riparian canyons. Seen occasionally at lower edge of ponderosa pine forest.

Lampornis clemenciae, Blue-throated Hummingbird†. — Uncommon in riparian habitats but regular at the station feeders. Two nests each containing two eggs were located on 28 June 1965, in the South Fork of Cave Creek Canyon. This species is very aggressive and was seen driving other species from feeding sites and destroying nests of other hummingbirds to obtain nesting materials.

Amazilia verticalis, Violet-crowned Hummingbird*. — First seen at Station in June in 1963, 1964, and 1965. R. W. Lasiewski captured one in July 1965.

Trogon elegans, Coppery-tailed Trogon†. — Nest found near Sunny Flats Campground on 10 June 1964; the two young fledged on 15 July. This species was seen in 1964, 1965, and 1966. In 1965 it was common in the South Fork of Cave Creek Canyon, where on 23 May Balda observed three males and two females in close proximity. Males wandered great distances up and down Cave Creek Canyon.

Colaptes cafer, Red-shafted Flicker†. — Common in woodland and coniferous forest. Eight nests were found; extremes are 2 May to 24 June.

Melanerpes formicivorus, Acorn Woodpecker†. — Common to abundant resident of Cave Creek Canyon. Numerous nests were found.

Dendrocopos villosus, Hairy Woodpecker†. — Abundant in coniferous forest. Young left nest below Flys Peak on 24 June. Two nests were located near the Station, one in a walnut, the other in a sycamore, well below the usual altitudinal breeding range of this species.

Dendrocopos scalaris, Ladder-backed Woodpecker†. — Uncommon in desert scrub lowlands surrounding mountains. Seen foraging as high as 5200 feet on xeric slopes. Two nests, each in agave, were located on 25 May 1964. Both contained three young.

Dendrocopos arizonae, Arizona Woodpecker†. — Common in oak and pine-oak woodland, but often silent and difficult to locate. Nests were found in sycamore, cottonwood, and walnut trees.

Tyrannus verticalis, Western Kingbird†. — Common in desert but rare in higher woodlands. Three of four nests in desert scrub were located on the high flower stalk of a yucca. The earliest nests located were being built on 23 May 1965.

Tyrannus vociferans, Cassin's Kingbird†. — Uncommon in woodlands up to 7000 feet. Two nests were located in oaks, another in a sycamore.

Myiodynastes luteiventris, Sulfur-bellied Flycatcher†. — Common in the lower portion of Cave Creek Canyon, less so near the Station. Four nests, all in sycamore cavities, were located between Stewart Forest Camp and Sunny Flats campgrounds in 1964. In 1966, the first egg was laid in a nest near the Station on 25 July.

Myiarchus tyrannulus, Wied's Crested Flycatcher*†. — Uncommon in Cave Creek Canyon. Nest containing well-grown young located high in a cavity in a sycamore on 7 July 1966.

Myiarchus cinerascens, Ash-throated Flycatcher†. — Common in all wooded habitats from desert through pine-oak woodlands. Highest density found in the latter. Five nests found in cavities or dead oak stumps. Earliest nest was being constructed on 9 May 1965.

Myiarchus tuberculifer, Olivaceous Flycatcher. — Common in canyons.

Sayornis nigricans, Black Phoebe†. — Uncommon. In 1964 and 1965 occupied nests were located under the bridge at Stewart Forest Camp. In 1965 a nest was also located under the bridge near the Station and on the eave of a station building (four eggs on 8 May).

Sayornis saya, Say's Phoebe†. — Uncommon at lower elevations but common near buildings and other man-made objects. Nested at Station each year, 1964-67.

Empidonax difficilis, Western Flycatcher†. — Common in ponderosa pine forest; abundant in spruce-Douglas fir forests on the peaks. Four nests were located in 1965. One nest with three eggs was located on 1 June in an upturned root system of a large pine. The other nests were located in cavities or attached to the side of rough-barked trees.

Empidonax fulvifrons, Buff-breasted Flycatcher*. — One or two pairs spent the summer of 1965 in the oak-juniper woodland behind the Station. First seen on 8 May.

Contopus pertinax, Coue's Flycatcher†. — Common in ponderosa pine forest where one nest was located in 1964 and two in 1965. The earliest nest was being built 20 May. Two stub-tailed young were taken on 28 June 1964.

Contopus sordidulus, Western Wood Pewee†. — Abundant.

Nuttallornis borealis, Olive-sided Flycatcher*. — One migrant seen on 30 May 1965, in ponderosa pine forest.

Pyrocephalus rubinus, Vermilion Flycatcher†. — Rare at lower elevations except near irrigated areas or human habitation. Male collected at Cave Creek Cabins near Portal on 28 June 1964. Male seen as high as the Station on three different occasions.

Camptostoma imberbe, Beardless Flycatcher*. — Rare on the dry slopes and open canyon floors of Cave Creek. Six sight records by Balda from March through July 1965, from below Stewart Forest Camp up to South Fork.

Eremophila alpestris, Horned Lark†. — Common in all grasslands.

Tachycineta thalassina, Violet-green Swallow. — Common at all elevations in the mountains.

Hirundo rustica, Barn Swallow*†. — Rarely seen foraging over desert scrub to woodlands. One nest with three young found in rancher's barn 12 miles south of Apache.

Progne subis, Purple Martin. — Uncommon.

Cyanocitta stelleri, Steller's Jay. — Common in higher riparian and coniferous forest.

Aphelocoma coerulescens, Scrub Jay*. — Seen rarely in thick foliage at low elevations. One seen one and one-half miles east of Portal on 20 June 1964; another seen 13 May 1967 near Cave Creek Cabins, between Portal and the entrance to Coronado National Forest. Three to five seen 10 July 1964, nine miles southwest of Apache, at the edge of oak woodland.

Aphelocoma ultramarina, Arizona Jay. — Common. Stub-tailed young seen 28 May 1964; one taken on 3 July 1964. Three nests found in May 1965, all with four eggs.

Corvus corax, Raven. — Rare at high altitudes. Seen frequently along the highway 15 miles north of Douglas, Arizona.

Corvus cryptoleucus, White-necked Raven†. — Uncommon on the desert. One nest containing two young was located in a clump of yucca west of the mountains in 1965.

Parus sclateri, Mexican Chickadee†. — Common but secretive during nesting in the ponderosa pine forest. Nest located in gambel's oak cavity on 10 June 1964.

Parus inornatus, Plain Titmouse*†. — Uncommon in and around Cave Creek Canyon, but fairly common in oak woodlands in more xeric areas. One nest was located behind the Station in a cavity of a dead juniper on 12 June 1965. Young left this nest on 19 June.

Parus wollweberi, Bridled Titmouse†. — Common in oak woodland, pine-oak-juniper woodland and riparian. It overlapped with the Plain Titmouse in the first two communities. Five nests were found in natural cavities of oaks and sycamore. The earliest nest located had three eggs on 1 May while the latest nest had seven young on 6 June.

Auriparus flaviceps, Verdin†. — Uncommon on the desert. Four nests were found in 1965 and one in 1964. A male was observed building a nest, which was never completed, on 31 March. A nest with four eggs was found on 24 May 1964; another, containing one egg was located on 2 June 1965. Immatures were observed building roost nests on three occasions.

Psaltiparus minimus, Bushtit†. — Common in oak-juniper and riparian woodlands, uncommon in open oak woodland. Three nests were found in 1965; the earliest was under construction on 4 April. Young left this nest about 7 May. The latest nest was found 29 May; the young fledged on 19 June.

Sitta carolinensis, White-breasted Nuthatch†. — Most common in ponderosa pine forest. Breeds sparsely in riparian habitat, oak-juniper woodland, and spruce-Douglas fir forest. One nest found with young on 17 June in a natural cavity in silver-leaf oak.

Sitta canadensis, Red-breasted Nuthatch†. — Common only in spruce-Douglas fir forest where one nest was observed being built on 24 May 1965.

Sitta pygmaea, Pygmy Nuthatch†. — Abundant in all coniferous forest from 5,000 feet to top of mountain. Nine nests found in 1965. First young left the nest on 14 June.

Certhia familiaris, Brown Creeper. — Abundant in spruce-Douglas fir and common wherever conifers are present. Immatures move downward in late June. An immature female was collected at Sunny Flats Campground on 30 June 1964.

Troglodytes aedon, House Wren†. — Common in coniferous forests, where four nests were located in 1965. All contained young by the last week of June.

Thryomanes bewickii, Bewick's Wren†. — Abundant in oak woodland, common in oak-juniper woodland. Five nests located in natural cavities of Emory Oak. The earliest nest was under incubation on 19 May, while the latest was being built on 5 June.

Campylorhynchus brunneicapillum, Cactus Wren†. — Common on desert scrub surrounding the mountain. Eighteen nests found in 1965; dates ranged from 24 March to 21 July.

Catherpes mexicanus, Cañon Wren. — Uncommon.

Salpinctes obsoletus, Rock Wren. — Rare.

Mimus polyglottos, Mockingbird. — Uncommon in desert but common in open oak-woodland.

Dumetella carolinensis, Catbird*. — Migrant, seen by Balda on 9 May 1965.

Toxostoma bendirei, Bendire's Thrasher. — Rare in desert scrub.

Toxostoma curvirostre, Curved-billed Thrasher*†. — Uncommon in desert. Nesting range overlaps with Bendire's Thrasher at the foot of the mountain. Five nests found, four of which were slung between two yuccas. The earliest nest had three eggs on 4 May, the latest had three eggs on 28 May.

Toxostoma dorsale, Crissal Thrasher†. — Rare from desert up to open oak woodland. Four nests, all containing eggs, were located; three were found in late May, one on 9 July.

Turdus migratorius, Robin†. — Common in riparian and ponderosa pine but uncommon in oak-juniper woodland and spruce-Douglas fir forest. Five nests found in 1965, the earliest with two young on 28 May.

Hylocichla guttata, Hermit Thrush. — Common in coniferous forests where moisture is available, extending down into moist shaded canyon bottoms. A female with a fresh brood patch was taken along the South Fork of Cave Creek on 14 May 1967.

Hylocichla ustulata, Swainson's Thrush*. — Uncommon migrant, seen in all years during the last two weeks of April and first two weeks of May. One captured and released at the Station on 14 May 1967.

Sialia sialis, Eastern Bluebird*†. — This species was first recorded as a breeding bird in Cave Creek Canyon in 1960 (Phillips, *et al.*, 1964: 131). It has since become a regular breeding species in the oak-juniper woodland and riparian habitat near the Station. Young left one nest on 12 June 1965; newly hatched young were in another on 7 July 1966.

Sialia mexicana, Western Bluebird†. — Abundant in ponderosa pine forest, where four nests were located. Young fledged in late June and the first two weeks of July.

Myadestes townsendi, Townsend's Solitaire. — Migrant (but *cf.* Tanner and Hardy, 1958). Latest sighting was 20 May 1964, near Herb Martyr Dam, by Ligon.

Polioptila caerulea, Blue-gray Gnatcatcher. — Common in oak woodlands.

Polioptila melanura, Black-tailed Gnatcatcher. — Rare in desert scrub.

Regulus satrapa, Golden-crowned Kinglet. — Common in spruce-fir forest but not found elsewhere.

Regulus calendula, Ruby-crowned Kinglet. — Abundant in spruce-fir forest but also limited to only this community.

Phainopepla nitens, Phainopepla*. — Rare breeder in desert scrub below Portal and also on the west side of the mountain. Records from June, July, and August, 1965.

Lanius ludovicianus, Loggerhead Shrike†. — Uncommon in most desert scrub areas but locally common. Three nests with four young each were found in 1965. Young left these nests on 12 May, 16 May, and 20 June.

Vireo huttoni, Hutton's Vireo†. — Uncommon in oak woodlands, more common in riparian situations. Nest found in sycamore on 15 May 1965.

Vireo bellii, Bell's Vireo. — Not uncommon in thick mesquite along dry creek beds east of Portal.

Vireo vicinior, Gray Vireo. — Of very local distribution. Found by Balda to be uncommon in oak woodland 20 miles southwest of Apache.

Vireo solitarius, Solitary Vireo†. — Abundant in ponderosa pine forest, and common in oak-juniper woodland and riparian communities. One nest with young found 11 June 1964; male parent taken. Four nests were found in 1965.

Vireo gilvus, Warbling Vireo. — Common in aspen stands, which are found at higher elevations. Seen on a few occasions as low as the Station.

Vermivora virginiae, Virginia's Warbler. — Uncommon in shrubby areas in both the coniferous forests and in riparian communities.

Vermivora luciae, Lucy's Warbler†. — Uncommon from desert through the woodlands. Nest found one and one half miles east of Portal on 9 June 1964.

Peucedramus taeniatus, Olive Warbler†. — Surprisingly common in the ponderosa pine forest in 1965; rare in spruce-Douglas fir forest. Two nests located in 1965 and one in 1967.

Dendroica petechia, Yellow Warbler. — One seen and heard repeatedly at the Station through the first two weeks of June 1963; no other records.

Dendroica caerulescens, Black-throated Blue Warbler*. — Casual migrant; seen by Balda on 7 May 1965 in riparian habitat.

Dendroica auduboni, Audubon's Warbler*. — Common in riparian and coniferous forests. One nest high in a ponderosa pine was located. Young left around 28 June.

Dendroica nigrescens, Black-throated Gray Warbler†. — Abundant in woodland and upper riparian communities. Six nests were found in 1965. Incubation was under way on 17 May in the earliest nest. Recently fledged young were common during the second and third weeks of June.

Dendroica townsendi, Townsend's Warbler*. — Uncommon migrant. Seen through the second week of May.

Dendroica graciae, Grace's Warbler†. — Very common in ponderosa pine forest. One nest with female incubating was found on 18 May 1965. A stub-tailed juvenile was taken on 21 June 1964.

Oporornis tolmiei, MacGillivray's Warbler*. — Common migrant. Seen in desert and woodlands into the third week of May. One captured and released at the Station on 15 May 1967.

Geothlypis trichas, Yellowthroat*. — One seen on station grounds on several occasions in May 1965.

Cardellina rubrifrons, Red-faced Warbler†. — Uncommon in coniferous forests and higher riparian communities. One nest found on 7 July 1965 in spruce-Douglas fir forest below Flys Peak contained four young.

Wilsonia pusilla, Wilson's Warbler. — Common near the Station in mid-May 1967.

Setophaga picta, Painted Redstart†. — Abundant in South Fork of Cave Creek Canyon. One nest located on 15 May contained four eggs. Juvenile just out of nest taken on 31 May 1964.

Passer domesticus, House Sparrow. — Common at Portal. One nest found in old woodpecker cavity.

Sturnella magna, Eastern Meadowlark†. — Common in grasslands below Apache.

Xanthocephalus xanthocephalus, Yellow-headed Blackbird*. — Rare at water tanks in higher desert scrub in July and August.

Icterus cucullatus, Hooded Oriole†. — Uncommon in desert and oak woodland. One pair, later collected, was observed building a nest in a large cottonwood one and one-half miles east of Portal on 8 June 1964. Another nest was found in oak woodland in late June 1965.

Icterus parisorum, Scott's Oriole†. — Uncommon in desert but common in oak woodland and on dry slopes. Five nests found in 1965. All were placed on the side of a yucca under the green leaves. Nest building was underway by 15 May and young were off the nest by 21 June. An independent juvenile was taken east of Portal on 28 June 1964.

Icterus bullockii, Bullock's Oriole*†. — Uncommon at Station and lower elevations where water is present. One nest was found on station grounds in June 1965. Two males were captured and released at the Station on 14 May 1967.

Euphagus cyanocephalus, Brewer's Blackbird*. — Not uncommon in large flocks at cattle feeder lots until the middle of May.

Molothrus ater, Brown-headed Cowbird†. — Uncommon from desert up through oak-juniper woodland. A recently-fledged juvenile that was attended by a female Vermilion Flycatcher was taken 28 June 1964. Three cowbird eggs were found in a Brown Towhee (*Pipilo fuscus*) nest on 11 June 1965.

Tangavius aeneus, Bronzed Cowbird*†. — Uncommon from desert up to lower edge of the oak woodland. Three taken on 26 May 1964. One male was molting. A Hooded Oriole nest contained two oriole eggs and one of this species.

Piranga ludoviciana, Western Tanager. — Common in ponderosa pine forest, less common in high riparian. Abundant at hummingbird feeders at the Station in mid-May 1967, apparently as a result of severe food shortage.

Piranga flava, Hepatic Tanager†. — Uncommon in pine-oak woodlands, upper riparian, and ponderosa pine forest. One nest was located high in a pine on 8 June 1965. The young fledged about 28 June.

Piranga rubra, Summer Tanager*. — Rare in cottonwoods and high riparian woodlands. One singing male was present at the Station from late May through June 1965.

Richmondena cardinalis, Cardinal. — Common in lower riparian.

Pheucticus melanocephalus, Black-headed Grosbeak†. — Common in oak and pine-oak woodlands and all riparian situations, but uncommon in ponderosa pine forest. Young were seen in mid-August.

Guiraca caerulea, Blue Grosbeak*†. — Uncommon in thick mesquite on the desert east of Portal. One of two adult males collected on 3 June 1964.

Passerina amoena, Lazuli Bunting. — Pair seen at the Station during the second week of May 1965.

Carpodacus cassinii, Cassin's Finch*. — Rare late spring migrant.

Carpodacus mexicanus, House Finch. — Common at low elevations.

Spinus pinus, Pine Siskin. — Seen about the Station in May.

Spinus psaltria, Lesser Goldfinch. — Uncommon along willow thickets in open riparian habitats.

Loxia curvirostra, Red Crossbill. — Sporadic in occurrence in 1965, but flocks of up to 50 birds, including many juveniles, were seen in pine-oak-juniper woodland and ponderosa pine in May and June. Seen in 1964, 1965, and 1967.

Chlorura chlorura, Green-tailed Towhee. — Seen through May in open riparian and pine-oak-juniper woodland. One was trapped and released at the Station on 24 May 1967.

Pipilo erythrophthalmus, Rufous-sided Towhee. — Uncommon but regular from oak woodland through spruce-Douglas fir forests.

Pipilo fuscus, Brown Towhee†. — Uncommon in all lower elevation shrubby habitats.

Calamospiza melanocorys, Lark Bunting*. — Large flocks were observed in the lowland shrub and oak communities until the second week of May. The last individuals left during the last week of May.

Passerculus sandwichensis, Savannah Sparrow*. — Seen commonly in vicinity of cattle watering tanks into the first week of May.

Ammodramus savannarum, Grasshopper Sparrow*†. — Uncommon on desert grassland between Apache and Douglas. Bob-tailed fledglings seen on 26 July 1965. Male with enlarged testes taken on 30 June 1964.

Ammodramus bairdii, Baird's Sparrow*. — Winter visitor. Uncommon on desert grassland into early May.

Chondestes grammacus, Lark Sparrow†. — Uncommon in shrub-grassland areas but common in open oak-woodland where three nests, all on the ground, were located. A nest found on 17 June contained one egg as did another located on 23 June. On 1 July, a pair was observed building a nest which contained three eggs eight days later. These are exceptionally late breeding records, as Brandt (1951) found nests in May and early June.

Aimophila ruficeps, Rufous-crowned Sparrow. — Uncommon to common in grassy woodlands.

Aimophila cassinii, Cassin's Sparrow*. — Rare, possible breeder on the grasslands south of Apache. Adult male with enlarged testes taken six miles south of Apache on 30 June 1964. Ohmart (1966) recently discovered *A. cassinii* breeding in Arizona (*cf.* statements of Phillips *et al.*, 1964: 200).

Amphispiza bilineata, Black-throated Sparrow†. — Abundant in desert scrub vegetation. Nest with three eggs found one and one-half miles east of Portal on 29 May 1964. Four nests found in 1965; the earliest was under construction on 12 May, whereas the latest held two eggs on 14 June.

Junco oreganus, Oregon Junco*. — Last seen on 15 May 1965 in pine-oak-juniper woodland and ponderosa pine forest.

Junco caniceps, Gray-headed Junco*. — Migrant. Last seen on 17 May 1965, in pine-oak-juniper woodland.

Junco phaeonotus, Mexican Junco†. — Abundant in coniferous forest. Ten nests found there in 1965. The earliest nest was being built on 17 May; the latest had three eggs on 1 August.

Spizella passerina, Chipping Sparrow†. — Common in oak woodland and abundant in open pine-oak-juniper woodland. Seven nests were found in the latter community in 1965. The earliest nest contained four eggs on 17 May, while the latest contained young on 12 June.

Spizella breweri, Brewer's Sparrow*. — Large flocks were present in low elevation shrubland until the end of May.

Spizella atrogularis, Black-chinned Sparrow*. — One seen at lower edge of oak woodland on 5 May 1965.

Zonotrichia leucophrys, White-crowned Sparrow. — Common migrant and winter resident at low elevations.

Melospiza lincolnii, Lincoln's Sparrow*. — One seen at the Station during the first two weeks of May 1965. Two seen at the Station in mid-May 1967.

Discussion

We recorded 167 species, of which 57 were not seen by Tanner and Hardy (1958). (Nineteen species recorded by us were winter residents or migrants not seen after May.) This is hardly surprising, as we spent much more time in this region, both within a single year and over a span of several years. Species for which we have breeding records,

or for which there is reason to assume breeding, that were unrecorded by Tanner and Hardy include: Peregrine Falcon, Harlequin Quail, Screech, Whiskered, Great-Horned, Pygmy and Elf owls, Wied's Crested Flycatcher, Buff-breasted Flycatcher, Barn Swallow, Scrub Jay, Curved-billed Thrasher, Audubon's Warbler, Bullock's Oriole, Bronzed Cowbird, Blue Grosbeak and Grasshopper Sparrow.

Of special interest are those species whose status apparently has changed during the recent past. The Golden Eagle appears to have decreased since the studies of Brandt (1951) and Tanner and Hardy (1958), whereas the Harlequin Quail apparently has increased. The Prairie Falcon may have become rarer, judging from the comments of Phillips *et al.* (1964: 26), as a result of movement of the Peregrine Falcon into southern Arizona. Our probable breeding record of the Peregrine in Cave Creek Canyon agrees with this; Tanner and Hardy recorded only the Prairie Falcon there. The hummingbirds have either increased in numbers or in conspicuousness or both, largely as a result of the many birders, both inside and outside the station grounds, who put up hummingbird feeders. The Violet-crowned Hummingbird has extended its range northward, as pointed out by Phillips *et al.*, (1964: 65) and is now regular at the Station. Neither Brandt (1951) nor Tanner and Hardy (1958) recorded the Plain Titmouse and Phillips *et al.* (1964: 111) report it only from the northern Chiricahua foothills. We found it using natural cavities throughout the woodlands. The Coppery-tailed Trogon and Buff-breasted Flycatcher apparently occur irregularly in southern Arizona, and we were fortunate to be in the area in a year (1965) when both were present; the trogon was actually almost common.

Tanner and Hardy listed many cavity nesters as uncommon or rare. This was not borne out by the census data of Balda. The density of the Western Bluebird was 20 pairs per 100 acres in ponderosa pine forest. The Red-breasted Nuthatch also was listed as rare in 1956, but 23 pairs per 100 acres were recorded in spruce-fir forest. This suggests a recent increase in the abundance of cavity nesters. Severe drought conditions have killed large numbers of trees in the past few years, indirectly providing numerous new nest sites for these cavity nesters. As mentioned earlier, the Eastern Bluebird (apparently *S. s. fulva*), another cavity nester, has also become established recently in areas near the Station. Balda found the density of this species to be 3 pairs per 100 acres in 1964 and 7 pairs per 100 acres in 1965. Ligon (in press) describes nest sites of this species in Cave Creek Canyon and mentions some factors which possibly serve to limit its increase.

ACKNOWLEDGMENTS

In 1964 Ligon received financial aid, in the form of a summer training grant, from the United States Public Health Service and from a grant provided by the Josselyn Van Tyne Memorial Fund of the American Ornithologists' Union. Both Ligon and Balda received grants from the Frank M. Chapman Memorial Fund of the American Museum of Natural History in 1965, supporting independent research in the Chiricahuas. Ligon also received assistance from a grant to The University of Michigan Museum of Zoology from the National Science Foundation Training Program in Systematics and Evolutionary Biology (GB-3366), and Balda's work was in part supported by the University of Illinois Research Board.

LITERATURE CITED

BALDA, R. P.
1967. Ecological relationships of the breeding-birds of the Chiricahua Mountains, Arizona. Unpubl. Ph.D. thesis, University of Illinois.

BRANDT, H.
1951. Arizona and its bird life. The Bird Research Foundation. Cleveland.

LIGON, J. D.
Factors influencing breeding range expansion of the Eastern Bluebird (*Sialia sialis*). Wilson Bull.. In press.

Ohmart, R. D.
1966. Breeding record of the Cassin Sparrow (*Aimophila cassinii*) in Arizona. Condor, 68: 400.

Peterson, R. T.
1948. Birds over America. Dodd, Mead, and Co. New York.

Phillips, A. R., J. T. Marshall, Jr., and G. Monson
1964. The birds of Arizona. Univ. Arizona Press, Tucson.

Tanner, J. T., and J. W. Hardy
1958. Summer birds of the Chiricahua Mountains, Arizona. Amer. Mus. Novitates. 1866.

Whittaker, R. H., and W. A. Niering
1965. Vegetation of the Santa Catalina Mountains, Arizona: A gradient analysis of the south slope. Ecology, 46: 429-452.

Accepted for Publication 11 January 1968

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S-NA - San Diego

A BIOLOGICAL SURVEY OF BAHIA DE LOS ANGELES, GULF OF CALIFORNIA, MEXICO. I. GENERAL ACCOUNT.

J. LAURENS BARNARD AND JOHN R. GRADY

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NATURAL HISTORY

VOL. 15, NO. 6, 17 JUNE 1968

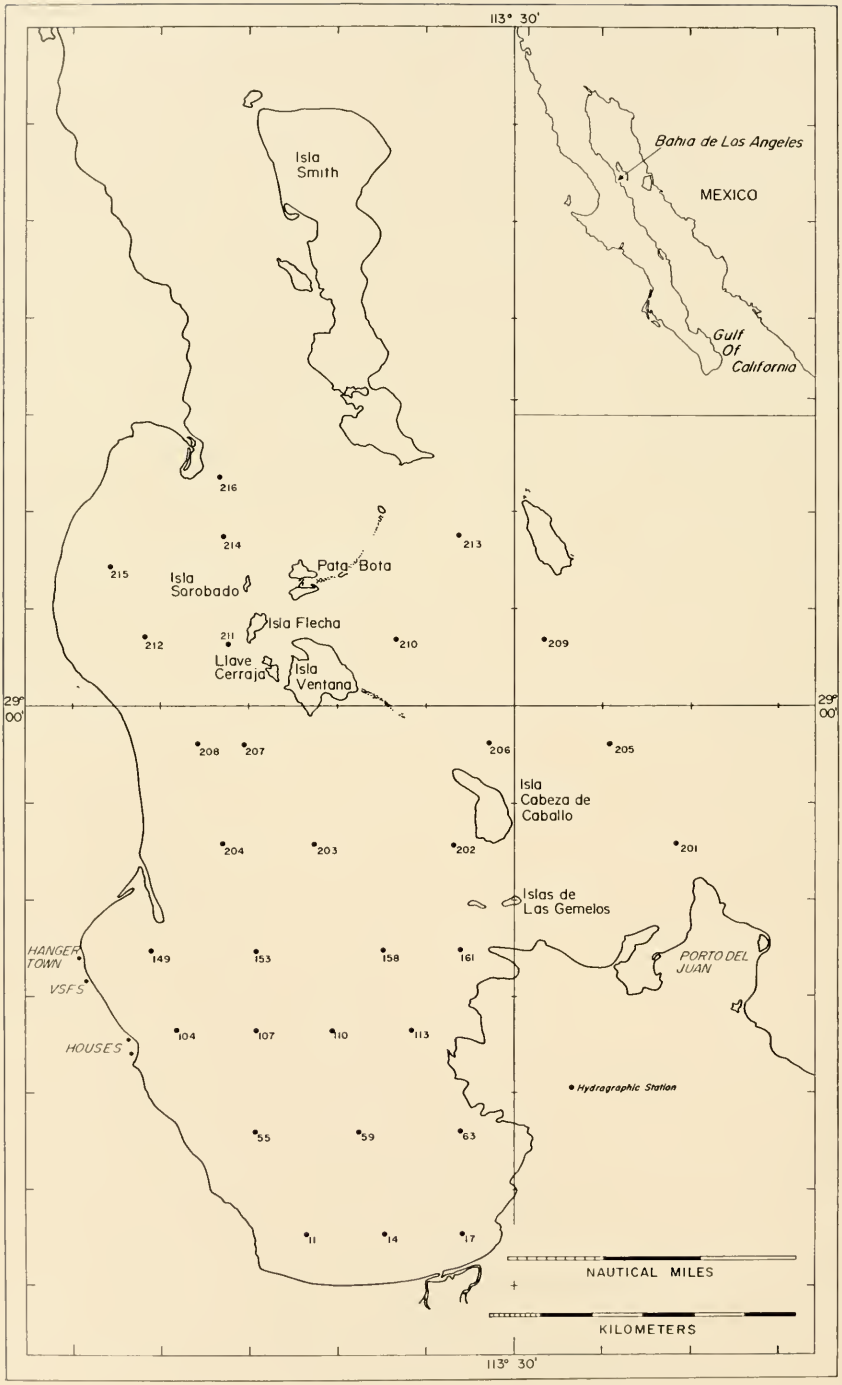

Figure 1. Plan of hydrographic stations in Bahia de Los Angeles; inset, location of bay in Gulf of California.

A BIOLOGICAL SURVEY OF BAHIA DE LOS ANGELES, GULF OF CALIFORNIA, MEXICO. I. GENERAL ACCOUNT

J. Laurens Barnard and John R. Grady

Abstract. — The benthic invertebrate fauna of the southern end of Bahia de los Angeles, a small bay on the Gulf of California, Mexico, was sampled during April 1962 and October 1963. 71 stations were occupied in 1962 and 91 stations in 1963. Invertebrate samples were collected with an orange-peel grab. The sediments on the bottom of the bay are predominantly brown, micaceous coarse silts and fine sands; the steep fringes are composed of gray, fine and medium sands on the shoreline facing the source area, a granite massif; the shore and fringing shelves on the peninsula and barrier islands fronting the bay are primarily shell fragments and rocks. There is free water circulation in the bay, although slight hypersaline conditions exist in summer. Dissolved oxygen ranges from 3.0 to 7.0 + ml/L in surface waters and drops to 1.66 ml/L in bottom waters of 75 to 98 m. Low level red-tides occur in March and April, and these may affect the invertebrate fauna. Lunar tides are of a mixed semi-diurnal type. Because winter hydrotemperatures drop below 15C the bay has the aspect of a warm-temperate province rather than a purely tropical region. Large scale reductions in the invertebrate fauna occurred prior to the start of the survey and between the April 1962 and October 1963 survey. The cause of these reductions is still unknown. Detailed reports on the fauna will appear elsewhere in this series.

Resumen. — En Abril de 1962 y Octubre de 1963 se obtuvieron muestras de invertebrados bentónicos en el extremo meridional de Bahía de los Angeles, Baja California, México. En total se ocuparon 71 estaciones en 1962, y 91 en 1963. Los sedimentos del fondo de esta bahía son predominantemente de color pardo, micaceos, con fango de partículas gruesas y arenas finas. Los bordes pendientes están constituidos por una franja de arenas grises de grano medio y fino, en la banda costera frente a un macizo granítico; de modo que la costa y las plataformas de la ribera de la peninsula y las islas que forman una barrera a la entrada de la bahía, están formadas primordialmente de fragmentos de rocas y conchas. El agua circula libremente en esta bahía, aún cuando en el verano se presentan ligeramente hipersalinas. El oxígeno disuelto fluctúa de 3.0 a 7.0 + ml/l en las aguas superficiales, descendiendo a 1.66ml/l en las aguas del fondo, a los 75 a 98m de profundidad. Mareas rojas de poca intensidad se presentan en Marzo y Abril, las cuales posiblemente afectan a esta fauna de invertebrados. Las mareas lunares son una mezcla del tipo semidiurno. La temperatura del agua desciende en el invierno por debajo de los 15C de modo que esta bahía pertenece más bién a una provincia cálido-templada, que a una región puramente tropical. Esta fauna de invertebrados sufrió una reducción en gran escala antes de iniciar estos estudios y entre los periodos de Abril, 1962, y Octubre de 1963. Se desconocen las causas que motivaron tales bajas. Un estudio detallado de esta fauna aparecerá en otra parte de estas series.

A study of the marine environment and invertebrate fauna of Bahia de los Angeles, by the writers and their colleagues, was suggested by the symposium on "The Biogeography of Baja California and Adjacent Seas" (Systematic Zoology, vol. 9, pts. 1-3, 1960), and made possible by the establishment of the Vermilion Sea Field Station of the San Diego Natural History Museum at Bahia de los Angeles. Our desire to study undisturbed shallow-water areas have also prompted this study, which followed guidelines similar to those used in the biological survey at Bahia de San Quintin (Barnard, 1962).

Because quantitative biological studies in a small area in the Gulf of California have not been made previously, the present survey has concentrated primarily on the occurrence, distribution, and density of benthic, soft-bottom, invertebrate populations. A study of sedimentary structure, bathymetry, and a bi-seasonal assessment of a few hydrographic parameters were made concurrent with the biological survey. This focus on a small community comes as an extension of the exploratory work of Parker (1964), who assembled data on the Gulf biotopes based primarily on the molluscan fauna.

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Figure 2. Aerial photograph of Bahia de Los Angeles.

Figure 3. Portion of village at Bahia de Los Angeles.

Human influence on the bay environment has probably been of little consequence. The hunting of sea turtles (*Chelonia mydas carrinegra*) from small boats in the open Gulf provides the economic base for the small village situated on the central western shore of the bay. Fishing for the totuava (*Cynoscion macdonaldi*) appears to be more important to the north, at Bahia San Luis Gonzaga and at San Felipe, than at Bahia de los Angeles. The main tourist attraction is fishing, although there is some deer hunting in the winter months. Access to the area is largely by small private plane, although there are scheduled flights from Tijuana.

PHYSIOGRAPHY

Bahia de los Angeles is situated on the north east shore of Baja California. It is fronted at some distance off shore by Angel de la Guarda Island and closer, by numerous small islands (Figs. 1, 2). There are three main, deep channels into the bay.

Protection from easterly winds is rather good, although severe winds can create large waves passing westward through the channels between islands. A granite massif, part of the Sierra de San Borjas range, flanks the west shore, (Fig. 3) and apparently deflects the northerly and westerly winds into winds with primarily westerly and southerly components as they pass across the shore (data from wind gauge established in April, 1962). At times, southerly and northwesterly winds meet on the sea in front of the village and create small water spouts.

The barrenness of the mountains and islands surrounding the bay results in a stark appearance. Sand or gravel beaches typify the western and southern shores, whereas the southeastern peninsula and most of the islands are beset by only cliffs and gravel ramparts. Despite the ruggedness of the subaerial topography the southern arm of the bay is remarkably flat (Figs. 4, 5).

The floor of the bay is in the form of a basin. It is tilted slightly west to east, and on the eastern shore is bounded by a small trench 1-2 meters deep. The basin shoals gradually to the south, where the initial dip is about 1°30′, but is reduced to 0°24′ from there to the geographic center of the southern portion of the bay, where depths are approximately 40 meters. Slopes on the east side, supported by volcanic extrusives, run to over 16°, in contrast to those off the sand beaches on the west side which are generally little over one degree.

FIELD METHODS

Hydrography. — Hydrographic surveys were conducted in April 1962, April 1963, and October-November 1963. Their timing coincided with the benthic biological surveys of April 1962 and October-November 1963. The April 1963 hydrographic survey acted as a control on year-to-year variability. The benthic surveys were planned to lag about two months behind the expected extreme water temperatures of mid-winter and mid-summer, in order to sample the accumulated results of the fauna's exposure to winter and summer seasons. Hence, the hydrographic surveys in both seasons represent approximately intermediate thermal conditions.

Hydrographic stations were established throughout the bay (Fig. 1), and each grid station was occupied for a two-day period. At each station the following parameters were studied at water depths of 0, 5, 10, 20, 30, 40, and 50 meters: salinity, temperature, dissolved oxygen, pH, silicates, phosphates, and water turbidity. Temperature was recorded on paired protected-unprotected reversing thermometers attached to Nansen bottles for correlation with other water analyses. Thermoclines were studied with a 200-foot bathythermograph. A 24-hour sampling program was conducted at anchor to study relationships of water variables to tidal changes.

A portable tide gauge was erected at a depth of 1.3 meters at the lowest observed tide, and was maintained from 21 to 28 April, 1962, 13 to 21 April, 1963, and

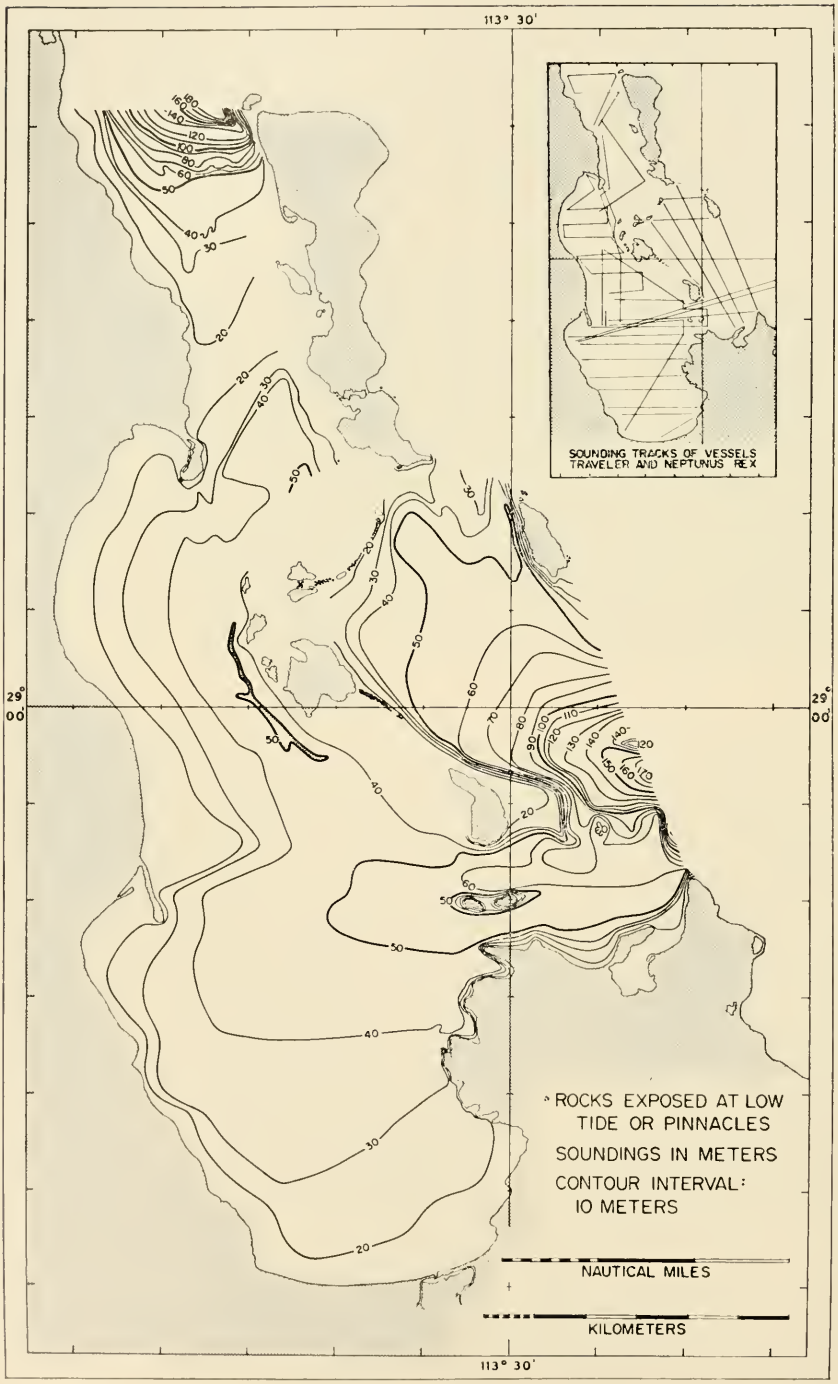

Figure 4. Bathymetry of Bahia de Los Angeles based on echo-sounding tracks of inset.

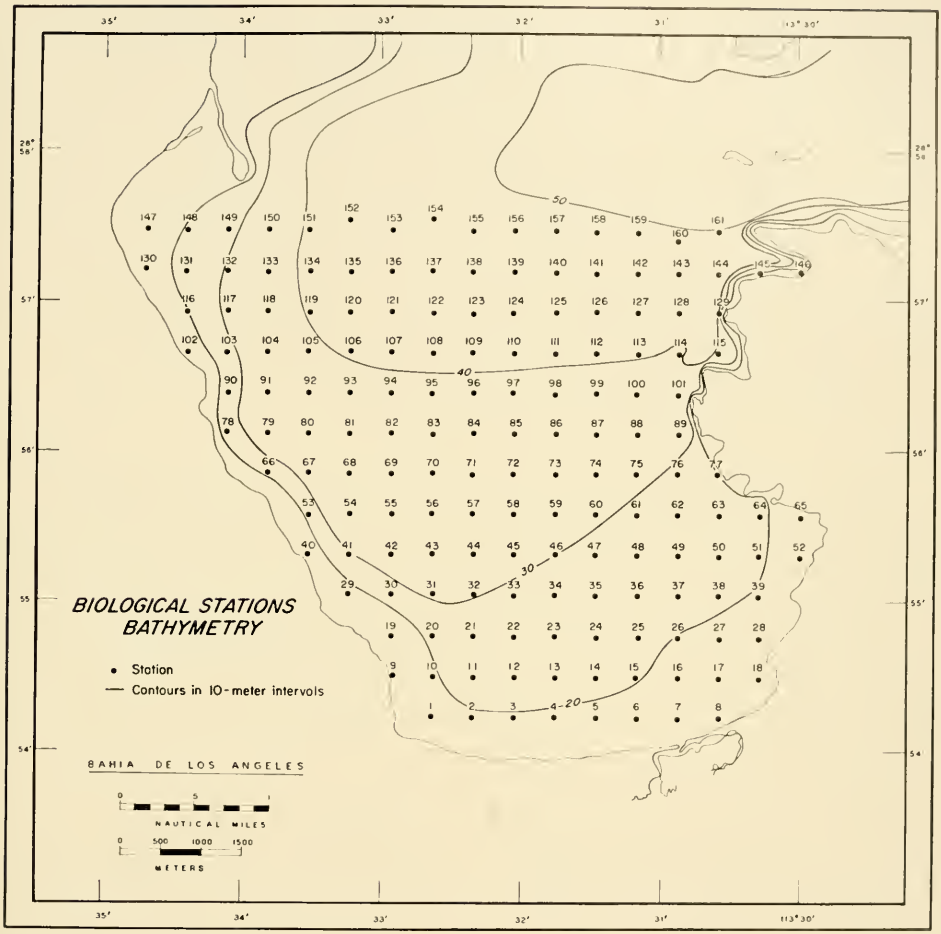

Figure 5. Depth contours and benthic biological stations in south portion of Bahia de Los Angeles.

25 October to 3 November, 1963. The gauge was attached to 5 meters of Orangeburg pipe suspended from a metal tripod.

A Simrad recording fathometer aboard the "Neptunus Rex" was used to record 38 profiles, totalling about 250 km. (Fig. 4), with radar navigation based on the chart prepared by Neil F. Marshall and Wendell R. Gayman of Scripps Institution of Oceanography on a scale of 1:2000. Radar navigation was checked continuously by pelorus readings from the ship's gyroscope system. Tidal observations were not used for adjusting profile records of the bathymetric survey precisely to datum, as other inaccuracies were of greater magnitude.

Biology. — A grid of benthic sampling stations was set up in the southern, most-protected portion of the bay, using procedures described by Barnard and Jones (1960) and Barnard (1962). Approximately 15 stations per square mile (nautical) were established, totaling 161 stations in an area about ten square miles (Fig. 5). Alternate stations were to be occupied in two seasons, the respective groups of 80 and 81 samples

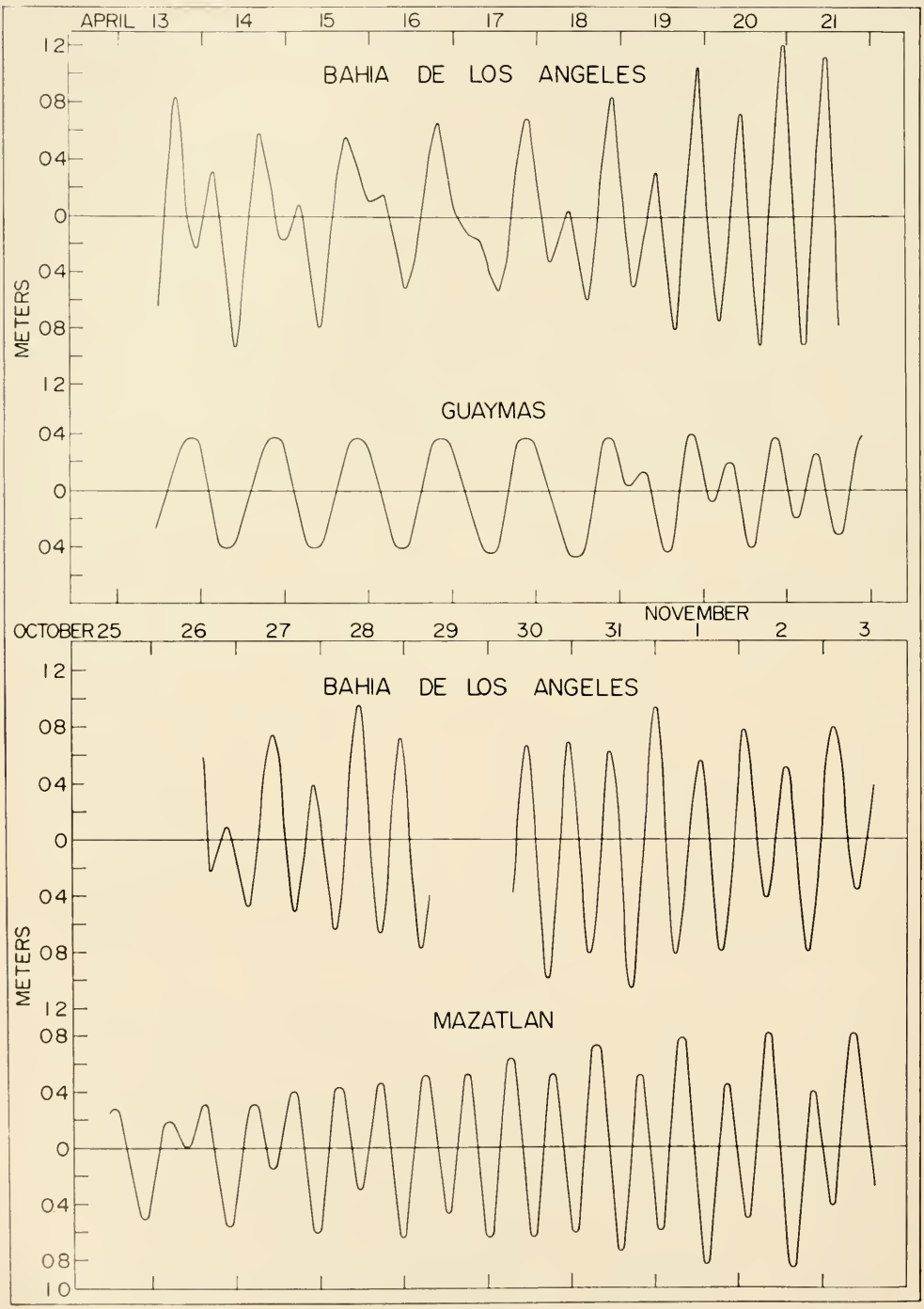

Figure 6. Marigrams of Bahia de Los Angeles compared with those of Mazatlan and Guaymas.

being of sufficient size and replicative variability to represent a matched pair, thus permitting a seasonal survey. If seasonal biotic differences proved to be minor, a better mapping of bottom areas would result than if 80 stations were duplicated in the two seasons. Owing to technical difficulties in April 1962 several stations were not occupied, and several samples were not recovered because of failure of the grab to penetrate the bottom. However, these stations were reoccupied in October-November 1963, resulting in groups of 71 (April) and 91 (October) samples. This departure from plan was less serious than expected. Seasonal differences were found to be so extreme that precise comparison was not believed to be necessary at this time.

Benthic biological samples were obtained with a Hayward orange-peel grab modified with canvas skirt and single-cable closing features. The sediments were washed through a Tyler Standard Screen Scale Sieve of 0.7mm mesh opening. The residues were preserved in formaldehyde, sorted in the laboratory, and subsequently preserved in alcohol. After gross examination of dominant organisms the sorted samples were forwarded to specialists for study. Detailed faunal reports based on these collections appear elsewhere in this series.

Sediment samples were collected at each station for determination of grain size (median diameter), organic carbon, calcium carbonate contents, and pH at each station. Water clarity readings were made with a Secchi disc, and surface-water temperatures with a centigrade thermometer in bucket samples, as well as with a Yellow Springs model 43TJ thermistor. Hydrographic casts with Nansen bottles and reversing thermometers, and bathythermograph tracings for thermoclines were taken at every second or third station during the biological survey.

Bottom depths from sea-surface were taken from the fathometer, checked by lead soundings, and corrected subsequently by construction of a bathymetric chart approximately to tidal datum.

The various parameters of the stations sampled are summarized in the Appendix.

Physical Observations

Bahia de los Angeles is open sufficiently to Ballenas Channel to permit free water circulation. Salinities in all three hydrographic surveys were in normal ranges for the upper Gulf, showing very slight hypersaline conditions in the upper 10 meters owing to evaporation during summer months. According to Roden and Groves (1959) salinity values in Ballenas Channel range from 35.2 to 35.3‰. In the Bay in April 1963 we recorded a surface salinity of 35.25‰ and at a depth of 30 meters 35.10‰; in October 1963 surface salinities were approximately 35.55‰ and at 30 meters 35.45‰.

Water temperatures in the bay are apparently extreme for a warm-temperate latitude. Not many data have been taken, but those records available show minima of less than 15C in February 1962 and 1963 and maxima of 29.8C in August 1962, 28.5C in August 1961 and 28.7C in September 1963.

Dissolved oxygen in the bay at depths of 50 meters or less always exceeded 3.0 ml/L in waters from 10 meters above the bottom to the surface. Occasionally, in the bottom waters from 0 to 10 meters above, in depths exceeding 30 meters, the dissolved oxygen values were between 2.0 and 3.0ml/L. Bottom water in depths of 75 to 98 meters dropped to a low of 1.66 ml/L. No attempt was made to sample at greater depths. The water between the surface and 30 meters was consistently better oxygenated, being as much as 3.0 ml/L higher in spring than in fall. In April 1962 dissolved oxygen at 10 selected stations in 25 meters depth ranged from 4.13 to 7.16 ml/L, whereas in October-November 1963 the range in 20 meters was between 4.0 and 5.0 ml/L. These differences presumably result from winds in the spring in addition to other factors.

Figure 7. Sediment distribution in south portion of Bahia de Los Angeles.

Bahia de los Angeles lies in the middle of more than 100 miles of coastline known for extensive upwelling (Byrne and Emery, 1960; chart compiled in Parker, 1964), which enriches surface waters and permits plankton blooms. Small but dense patches of red-tide were observed almost continuously during April of 1962 and 1963, and during a reconnaissance trip in March 1961.

Marigrams show the tides to be of a mixed semidiurnal type which, during the periods measured, had a mean range of 1.22 meters and a high water interval of slightly more than 12 hours (Fig. 6). The maximum range recorded in April 1962 and 1963 was 2.2 meters, and in October-November 1963, 2.0 meters; maximum spring tides did not occur during these periods. The tides exceed the spring range, which increases progressively toward the head of the Gulf, of 0.8 meters at the reference tide station at Guaymas, and 1.3 meters at Mazatlan. In Figure 6, the marigrams for April are contrasted with tidal curves from Guaymas, and for the period in October-November with a plot of the predicted tides at Mazatlan computed from the reference station at San Diego, California. The mixed tides of Bahia de los Angeles resemble the semidiurnal tides

at Mazatlan just south of the entrance to the Gulf, more than they do those at Guaymas, Bahia Concepcion or La Paz, which are characterized by dominant diurnal components.

The sediment pattern (Fig. 7) in the bay apparently conforms with water depth. Gray sands occur on the western and southern shores from the beach seaward to depths of 20 to 25 meters, grading into silty sand and sandy silt at 20-35 meters. Brown silt forms a cover in depths exceeding 35 meters. A belt of black silt mixed with sand also is present along the south margin of the bay (stations 1 to 8). Seaward of the black sediment is a region of gray, medium and fine sands. The eastern shore is dominated by sands and silty sand with a high content of shell particles, rocks, and coarse debris. Fine sediments apparently have their source on the western and southern margins of the bay, whereas shell fragments remain exposed on the eastern margin where little sediment is supplied from the land. Barrier islands are also surrounded by shell fragments. The abundance of mica in the marine sediments probably indicates the chief source of sediment to be the southern granitic intrusive.

Biological Observations

Benthic samples of April 1962 included large and diverse populations of polychaetes, small pelecypods, amphipods, mysids and small shrimps on muds in depths exceeding 5m. Grab samples on sand bottoms of 2-5m depth fringing the bay were poorly populated, but dredgings accumulated large masses of red algae and numerous crustaceas. Mud bottom samples taken in October-November 1963 appeared highly impoverished and the paucity of organisms was confirmed by frequent utilization of a Van Veen grab in which no losses of mud could occur. (The Van Veen samples are not included in the results of this survey.) Thus, a severe reduction of the benthic fauna had occurred between the sampling periods. Seven benthic samples from Bahia Concepcion (150 miles southeast of Bahia de los Angeles) in early November 1963 yielded less than 10 macroscopic organisms (polychaetes, nemertean, crabs, stomatopod). This fauna, therefore, was even more impoverished than that of Bahia de los Angeles.

The diminutive size of benthic pelecypods in depths of 10-40m in April 1962 suggests that another reduction had occurred in 1961. In late 1963, population densities of many amphipods and polychaetes were less than half those of early 1962. Samples from October 1963 showed many shell fragments but few whole shells of pelecypods. If benthic predators or scavengers (elasmobranchs) had pulverized these shells, a remarkable efficiency would have to be assumed.

Bottom waters of Bahia de los Angeles and Bahia Concepcion showed no reduction in dissolved oxygen and no trace of hydrogen sulphide was found in water or muds during the several surveys. Small patches of red tide were observed in March-April of 1961, 1962, and 1963, and Dr. D. J. Reish has informed us that severe biotic depletion occurred in Alamitos Bay, California, during and after periods of red-tide. But the red-tide so far observed at Bahia de los Angeles has been minor. The cause of faunal reduction is still unknown. However, windrows of large pelecypods and gastropods on the southwest shore of Bahia de los Angeles suggests that severe depletion of bottom populations is not an annual phenomenon.

Acknowledgements

This project was supported by matched funds from the National Science Foundation (G-20909) and the Beaudette Foundation of California. The laboratory work was completed under auspices of the Smithsonian Institution. Richard F. Dwyer of Los Angeles generously provided his 65-foot converted shrimp-trawler "Traveler" for the first expedition, and the Beaudette Foundation, through John P. McNabb of Los Angeles, provided the 97-foot North Sea Trawler "Neptunus Rex" for the second and third expeditions. The San Diego Museum of Natural History, through its former director Dr. George E. Lindsay, provided quarters and work space at the NSF-suported Vermilion Sea Field Station. Dr. and

Mrs. Carl L. Hubbs generously donated numerous specimens of marine invertebrates collected by their SCUBA teams and thus provided representatives of species we would not have obtained otherwise. The U. S. Coast and Geodetic Survey kindly donated a portable tide gauge.

The success of this project is due directly to the generosity of the following persons, each of whom supported it financially and each of whom untiringly worked in the field: Palmer T. Beaudette, John P. McNabb, and Richard F. Dwyer.

For various courtesies extended we are grateful to: Allan J. Stover, Jr., James R. Stewart, Donald M. Dockins, Dr. Richard H. Rosenblatt, Keith W. Radford, Dr. Wayne J. Baldwin, John H. Emmel, David W. Hearst, W. W. Shannon, Lloyd R. Hales, Jr., and Fillmore T. Condit.

Literature Cited

Barnard, J. L.
1962. Benthic marine exploration of Bahía de San Quintín, Baja California, 1960-61. General. Pacific Natur. 3: 249-274.

Barnard, J. L. and G. F. Jones
1960. Techniques in a large scale survey of marine benthic biology, P. 413-447. *In*, E. A. Pearson [ed.] Waste Disposal in the marine environment. Pergamon Press.

Byrne, J. V. and K. O. Emery
1960. Sediments of the Gulf of California Bull. Geol. Soc. Amer. 71: 983-1010.

Parker, R. H.
1964. Zoogeography and ecology of some macroinvertebrates, particularly mollusks, in the Gulf of California and the continental slope off Mexico. Vid. Medd. Dansk Nat. Foren. 126: 1-178.

Roden, G. I. and G. W. Groves
1959. Recent oceanographic investigations in the Gulf of California. Sears Found., Jour. Mar. Res. 18: 10-35.

Accepted for Publication 26 March 1968

Smithsonian Institution, Washington, D.C., and Bureau of Commercial Fisheries, Fort Crockett, Texas.

APPENDIX

Table 1. Biological Stations in Bahia de los Angeles. L = sample taken from launch. Sediment types in parentheses indicate changes from field classification owing to laboratory determinations of sand-silt percentages. Depths represent corrected values from plots of bottom contours adjusted approximately to tidal datum.

Station	Date	Depth (m)	Surface Water Temperature (C)	Sediment
1 L	10-30-63	3		gray-black sand with silt
2 L	10-30-63	10		gray-black sand with silt
3 L	10-30-63	14		black very fine sand
4 L	10-30-63	7		black very fine sand
5 L	10-30-63	13		black very fine sand
6 L	10-30-63	12		black very fine sand
7 L	10-30-63	11		black very fine sand
8 L	10-30-63	4		gray sand
9 L	10-30-63	2		gray sand
10	4-24-62	17	19.7	gray-green fine sand
11	10-28-63	18	25.2	gray-green fine sand
12	4-24-62	15	19.7	gray-green silty sand
13	10-28-63	16	25.5	gray-green sand
14	4-24-62	15	19.4	gray-green silty sand
15	10-28-63	15	25.6	gray sand
16	4-24-62	13	19.9	gray silty sand
17	10-28-63	11	25.8	gray fine sand
18 L	4-24-62	5	20.2	hard bottom, no sample
	10-31-63			shell sand
19	4-24-63	19	19.1	gray-green fine sand
20	10-28-63	22	25.6	gray very fine sand
21	4-24-62	21	18.9	brown fine sand
22	10-28-63	22	25.7	gray very fine sand
23	4-24-62	20	19.2	gray-green silty sand
24	10-28-63	20	25.7	gray silty sand
25	4-24-62	17	19.2	brown silty sand
26	10-28-63	18	25.7	gray silty sand
27	4-24-62	13	20.0	greenish shelly silty sand
28 L	10-31-63	4		shell sand
29	4-24-62	17	19.9	greenish fine sand
30	10-28-63	24	25.9	gray-green very fine sand
31	4-24-62	25	18.1	gray-green fine sand
32	10-28-63	26	26.0	gray-green very fine sand
33	4-24-62	25	18.0	gray-green silty sand
34	10-28-63	24	25.9	brown silty sand
35	4-24-62	24	18.7	greenish-brown silty sand
36	10-28-63	24	25.9	brown silty sand
37	4-24-62	20	20.4	hard bottom, no sample
	10-28-63	20	26.2	brown silty sand
38	10-28-63	20	26.3	brown silty sand
39	4-24-62	7	21.6	gray medium sand
40 L	10-31-63	4		gray sand
41	4-27-62	21	18.1	medium silty (sand)
42	10-28-63	27	26.4	silty (sand)
43	4-27-62	30	18.1	silty sand
44	10-28-63	30	26.3	brown silt and fine sand
45	4-27-62	30	17.6	brown silty very fine sand
46	10-28-63	29	26.5	brown silty sand
47	4-27-62	25	17.9	brown sandy silt
48	10-28-63	24	26.2	brown silty sand
49	4-27-62	20	17.9	brown silty sand

Table 1. (Continued)

Station	Date	Depth (m)	Surface Water Temperature (C)	Sediment
50	10-28-63	18	26.2	brown silty sand
51	4-27-62	15	18.7	gray medium sand
52 L	10-31-63	9		gray sand
53	4-27-62	22	18.2	gray medium sand
54	10-28-63	31	26.4	brown silty (sand)
55	4-27-62	31	18.2	silty fine sand
56	10-28-63	31	26.4	silty (sand)
57	4-27-62	31	18.1	very fine sand
58	10-28-63	31	26.5	brown silty (sand)
59	4-27-62	31	17.9	brown silty sand
60	10-28-63	30	26.3	brown sandy silt
61	4-27-62	24	18.0	silty very fine sand
62	10-28-63	24	26.2	brown sandy silt
63	4-27-62	21	18.3	silty very fine sand
64	10-28-63	22	26.2	very fine sand
65 L	10-31-63	9		coarse shell sand
66	4-27-62	25	18.3	silty medium sand
67	10-29-63	27	24.9	gray fine silty sand
68	4-27-62	33	18.1	silty sand
69	10-29-63	33	25.3	brown silt
70	4-27-62	33	18.0	brown sandy silt
71	10-29-63	31	25.1	brown sandy silt
72	4-27-62	30	17.4	brown sandy silt
73	10-28-63	31	26.1	brown silt
74	4-27-62	30	17.7	sandy silt
75	10-28-63	30	26.0	brown silt
76	4-27-62	28	17.3	sandy silt
77	10-28-63	27	26.0	very fine sand
78	4-27-62	17	17.5	gray medium sand
79	10-29-63	27	25.4	gray silty fine sand
80	4-27-62	34	17.9	brown sandy silt
81	10-29-63	35	25.4	brown silt
82	4-27-62	35	17.6	brown sandy (silt)
83	10-29-63	35	24.3	brown silt
84	4-27-62	36	17.6	greenish-brown sandy silt
85	10-29-63	37	25.4	brown silt
86	4-27-62	34	16.9	brown silt
87	10-29-63	33	25.2	brown silt
88	4-27-62	33	17.3	brown silt
89	10-29-63	33	25.5	brown sandy silt
90	10-29-63	9	25.8	gray sand
91	4-28-62	34	17.7	brown silty sand
92	10-29-63	35	25.8	brown sandy silt
93	4-28-62	36	17.5	brown sandy silt
94	10-29-63	38	25.5	brown silt
95	4-28-62	38	17.3	brown silt
96	10-29-63	39	25.5	brown silt
97	4-28-62	37	17.8	brown silt
98	10-29-63	38	25.5	brown silt
99	4-28-62	37	18.2	brown silt
100	10-29-63	37	25.6	brown silt
101	4-28-62	37	18.2	silty sand with shells
102 L	10-31-63	6		gray sand
103	4-28-62	30	18.1	brown silty (sand)
104	10-29-63	38	26.0	brown silt
105	4-28-62	38	17.1	brown silt
106	10-29-63	40	26.0	brown silt

Table 1. (Continued)

Station	Date	Depth (m)	Surface Water Temperature (C)	Sediment
107	4-28-62	40	17.3	brown silt
108	10-29-63	40	26.0	brown silt
109	4-28-62	40	17.1	brown silt
110	10-29-63	40	26.0	brown silt
111	4-28-62	40	17.6	brown silt
112	10-29-63	40	25.8	brown silt
113	4-28-62	40	17.9	green sandy silt
114	10-29-63	39	26.2	brown sandy silt
115	10-29-63	37	26.3	very fine sand
116	4-24-62	6	19.8	gray medium sand
117	10-29-63	30	26.4	brown silty sand
118	4-22-62	34	20.1	brown sandy silt
119	10-29-63	40	26.2	brown silt
120	4-22-62	40	19.5	brown sandy silt and clay
121	10-29-63	42	26.1	brown silt
122	4-24-62	42	17.7	brown silt
123	10-29-63	42	25.2	brown silt
124	4-24-62	42	17.2	brown silt
125	10-29-63	42	26.2	brown silt
126	4-24-62	42	17.2	brown silt
127	10-29-63	42	26.1	brown sandy silt
128	4-24-62	42	18.3	brown sandy silt
129	10-29-63	18	26.2	reefy material
130	4-24-62	7	19.8	gray coarse sand, 3 poor grabs
131	10-29-63	24	26.5	brown silty sand
132	4-22-62	25	19.7	sandy silt with shells
133	10-29-63	35	26.2	brown silt
134	4-22-62	38	19.7	brown silty medium sand
135	10-29-63	42	26.2	brown silt
136	4-22-62	41	19.5	brown sandy silt
137	10-30-63	42	25.4	brown silt
138	4-22-62	46	18.5	brown silt
139	10-30-63	42	25.6	brown silt
140	4-24-62	44	17.4	no sample
	10-30-63		25.4	brown silt
141	10-30-63	46	25.0	brown sandy silt
142	4-23-62	46	18.1	brown sandy silt
143	10-30-63	46	24.9	brown sandy silt
144	4-23-62	44	17.9	brown silty sand
145	10-30-63	38	25.5	fine shelly silty sand
146 L	10-31-63	6		coarse shell sand
147	10-30-63	9	25.6	gray fine sand
148	4-23-62	15	19.5	gray fine sand
149	10-30-63	19	25.6	gray medium sand
150	4-23-62	29	18.9	hard bottom, no sample
	10-30-63		25.0	gray fine sand and shell sand
151	10-30-63	41	25.5	brown sandy silt
152	4-23-62	42	17.4	brown sandy silt
153	10-30-63	44	25.5	brown silt
154	4-23-62	44	17.4	brown silt
155	10-30-63	44	25.5	brown silt
156	4-22-62	46	18.3	brown silt
157	10-30-63	46	25.3	brown silt
158	4-23-62	46	17.7	brown silt
	4-23-62		17.4	brown silt
159	10-30-63	46	25.5	brown sandy silt
160	4-23-62	45	17.9	brown sandy silt
161	10-30-63	49	25.3	silt with shell sand

Table 2. Samples of Scripps Institution of Oceanography, Dr. Carl L. Hubbs and party

Station	Date	Depth (m)	Remarks
SIO-X	4-22-62	24	Piedras Ahogadas, 0.5 mi S Isla Ventana; SCUBA sample of bottom: shell frags., pebbles
SIO-62-210	4-18-62	shore	Isla Ventana, S shore of cove on W side of island: tailings of fish sample
SIO-62-212	4-19-62	shore	Isla Cerraja, E shore: tailings of fish sample
SIO-62-215	4-21-62	shore	Isla Ventana, Pta. Ventana: tailings of fish sample
SIO-62-216	4-21-62	shore	Reef between Isla Ventana and Isla Cabeza de Caballo: tailings of fish sample
SIO-62-228	4-24-62	2	W shore of bay, south of village: tailings of fish sample on cobble bottom
SIO-62-234	4-25-62	subtidal	Cove on E side of S arm of bay: 16-foot fish-trawl
SIO-62-235	4-26-62	subtidal	N of village sandspit: beach poisoning
SIO-62 236	4-26-62	?30	S arm of bay: shrimp trawl on shrimp boat on N-S line.

Table 3. Miscellaneous samples

Station	Date		Depth (m)	Remarks
210	4-27-62		9	Dredge: bag 1/3 full of gracilarioid algae, few *Polinices* egg-cases, one *Pecten*, a few bulls-eye shrimp; algae washed for small crustaceans; a few *Astropecten*
211	4-28-62		9-32	750m N of village sandspit, dredge; *Ulva* and gastropod egg cases, spider-crabs, 1 asteroid
212	4-28-62		9-16	Main W shore of bay, dredge: *Ulva*, gracilarioids, 2 asteroids
213	4-22-62		Intertidal	Vermilion Sea Field Station, rocks at low tide
214	4-22-62		Intertidal	Same locality: tunicates and sponges washed for crustaceans
301	3-10-61		6	OPG test sample, 1 mile S of Vermilion Sea Field Station
302	3-10-61		4	Same
303	3-10-61		Intertidal	Vermilion Sea Field Station, rocks: wash of *Sargassum* sp.
305	3-10-61		Intertidal	Same locality: wash of *Ulva* sp.
306	3-10-61		Intertidal	Same locality: wash of sandy rocks
306A	3-10-61		Intertidal	Same locality: wash of rocks below water level
350	11- 1-63		Intertidal	Same locality: wash of 2 rocks with muddy tubes
351	11- 1-63		Intertidal	Same locality: wash of sponge
352	11- 1-63		Intertidal	Same locality: wash of sponge
353	11- 1-63		Intertidal	Same locality: wash of algal clumps
354	11- 1-63		Intertidal	Same locality: wash of flabellinid alga
355	11- 1-63		Intertidal	Same locality: miscellaneous collections
910	11- 2-63	2-3		1.5 mi S of village on W side of bay, diving: *Sargassum* sp.
911	11- 2-63	surface	Plankton tow	
912	11- 2-63	surface	Plankton tow	

A BIOLOGICAL SURVEY OF BAHIA DE LOS ANGELES, GULF OF CALIFORNIA, MEXICO. II. BENTHIC POLYCHAETOUS ANNELIDS.

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VOL. 15, NO. 7, 17 JUNE 1968

A BIOLOGICAL SURVEY OF BAHIA DE LOS ANGELES, GULF OF CALIFORNIA, MEXICO. II. BENTHIC POLYCHAETOUS ANNELIDS.

Donald J. Reish

Abstract. The benthic polychaetous annelids of Bahía de los Angeles were studied quantitatively in April 1962 and October 1963. Distribution and sediment preferences of the principal species are summarized. Of the 112 species encountered, ninety were previously unreported from the Gulf of California. Six new species are described: *Microphthalmus riojai*, sp. n., *Aricidea (Aricidea) rosea* sp. n., *Prionospio longibranchiata* sp. n., *Pectinaria (Pectinaria) hartmanae* sp. n., *Euchone barnardi* sp. n., and *Euchone cortezi* sp. n. In April 1962, 39,470 specimens were collected; in October 1963, 7,100. The cause of this reduction is unknown, but high summer water temperatures may be involved. Previous reports of polychaetes from the Gulf of California are summarized.

Resumen. Los Anélidos Poliquetos bentónicos de la Bahía de los Angeles fueron estudiados cuantitativamente durante Abril de 1962 y Octubre de 1963. Se detalla la distribución de las especies principales, y las preferencias que presentan respecto a los distintos sedimentos. De las 112 especies registradas, solamente 22 han sido observadas previamente en el Golfo de California. Se incluye la descripción de seis especies nuevas: *Microphthalmus riojai* sp. n., *Aricidea (Aricidea) rosea* sp. n. *Prionospio longibranchiata* sp. n., *Pectinaria (Pectinaria) hartmanae* sp. n., *Euchone barnardi* sp. n., y *Euchone cortezi* sp. n. En Abril de 1962 se obtuvieron 39,470 ejemplares, y solamente 7,100 en Octubre de 1963. Se desconocen los factores causantes de esta enorme diferencia numérica; sin embargo, se considera que las temperaturas elevadas registradas durante el verano, pudieron ejercer una definida influencia en ese fenómeno. También se incluyen las observaciones previas correspondientes a los Poliquetos del Golfo de California.

Early accounts of polychaetes from the Gulf of California have been summarized by Rioja (1941). Subsequent information has been added by Rioja (1943; 1947a, b), Hartman (1944a, 1950), Treadwell (1942), Fauvel (1943), Woodwick (1961), and Parker (1963). However, no quantitative studies have been made. Previous quantitative studies of eastern Pacific polychaetes by Reish (see references) have dealt with nearly all the principal bays from Morro Bay, in central California, south to Bahía de San Quintín, Baja California. This paper, which summarizes the quantitative data on the distribution of polychaetes in Bahía de los Angeles, a small bay on the west side of the Gulf of California, and compares the fauna ecologically and zoogeographically with that of similar areas in southern California, extends the area of quantitative studies into a geographically disjunct area.

The specimens on which this report is based were collected by the Beaudette Foundation in April 1962 and October 1963 (see Barnard and Grady, 1968). Quantitative samples were taken at 79 stations in April 1962 and 82 stations in October 1963 (Fig. 1) using a modified size-one Hayward orange-peel bucket which samples an area of 0.06m^2. Three dredge hauls were made in April 1962. Samples were brought back to the base camp, washed through a 0.5mm screen and preserved in formaldehyde for later sorting. I wish to thank Dr. J. Laurens Barnard for making the collections available to me. My research was supported in part by a grant from the National Science Foundation (NSFG- 20909).

Chemical and Physical Data. — Salinity was measured throughout the bay in April 1962, April 1963, and October 1963 at water depths of 0, 5, 10, 20, 30, 40, and 50 meters. All values ranged from about 35.0 to 35.5 0/00, which coincide with the salinity values given for the upper Gulf of California by Parker (1963).

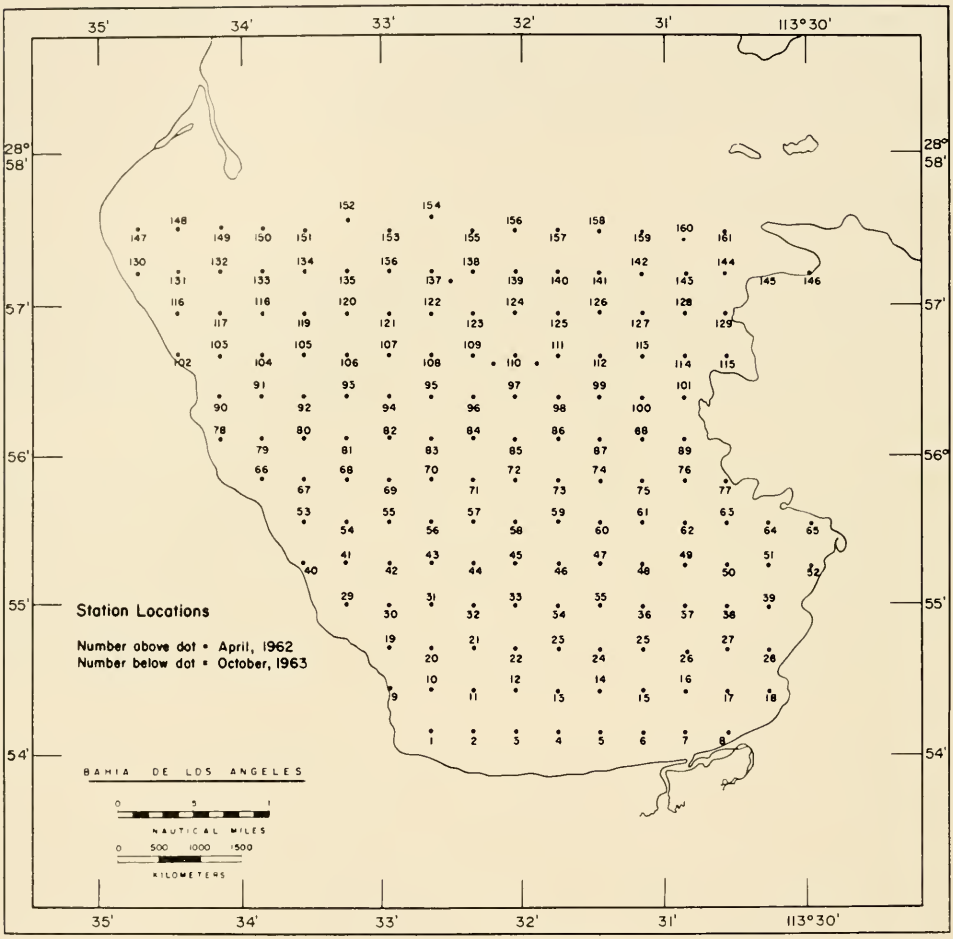

Figure 1. — Map of Bahia de los Angeles showing station locations.

Dissolved oxygen was measured at the same stations. Generally the dissolved oxygen values exceeded 3.0 ml/l with higher readings in April than in October. Bottom waters at depths of 75 to 98 meters reached lows of 1.66 ml/l.

Surface water temperatures were taken at the majority of the stations. They varied from 16.9 to 21.6 with a median of 18.2C. In general, warmer waters were found inshore in shallow waters and colder waters were encountered near the entrance of the bay. The warm temperatures occurred after the high summer air temperatures, and the colder temperatures followed the winter months. The warm water temperatures are believed to have influenced the marked reduction in the number of specimens collected in October 1963 as compared to the April 1962 survey.

Four kinds of sediments occur on the bottom of Bahía de los Angeles: sand, silty sand, sandy silt, and silt. Sand bottoms (40 stations) are present primarily along the shores of the bay. These are replaced by silty sand, (46 stations) and sandy silt bottoms (30 stations) in deeper waters. Silts (45 stations) are limited to the outer part of the bay (Barnard and Grady, 1968).

Discussion

Zoogeography.—A total of 112 species were encountered in this study. Specific identification was not possible for one species of *Arenicola* that was represented by a single incomplete specimen. Only 22 of these species, had previously been reported from the Gulf of California. Of the 90 species previously unknown from the Gulf of California, 72 have been taken from southern California waters, two from northern California, one from British Columbia, and one from Alaska (also Acapulco). Northern distributional extensions include four from the Pacific side of southern Mexico (including the one also known from Alaska), one from Panama, one from Peru, and two from the Central Pacific Ocean.

Table 1 (see Appendix) summarizes the distributional data on the polychaetes of the Gulf of California. Species previously unknown from the area are indicated by an asterisk; literature citations and locality data are included. Only included in Table 1 are those reports in which specific identification was made by earlier workers; excluded are reports to only family or genus. No attempt was made to determine or evaluate the identification of others, since their material was not at hand. However, evaluations or opinions of subsequent workers are included. Presently, 300 species of polychaetes are known from the Gulf of California. The quantitative survey at Bahía de los Angeles therefore increased the number known from 210. Probably this total will be increased by other quantitative studies.

Relationship of polychaetes to sediments. — As noted, four kinds of sediments were encountered on the benthos of Bahía de los Angeles. The relationships of the percentage occurrence and the average number of specimens per station of the principal polychaetes (based on the presence at 35 or more stations) to the general sediment type are given in Table 2. Since the number of stations characterized by a particular sediment varied, the occurrence of a species on a particular substrate is given in percentage units rather than according to the number of times it was found. In addition, the average number of specimens per station is a further indication of substrate preference or tendency. On the basis of this analysis, the most abundant species of polychaetes may be grouped as follows:

Preference for sand: *Pareulepis fimbriata, Ophiodromus pugettensis, Pilargis hamatus, Langerhansia heterochaeta, Ceratonereis mirabilis, Nereis procera, Glycera tesselata, Lumbrineris minima, Chaetozone corona, Armandia bioculata, Chone mollis.*
Preference for silty sand: *Eteone dilatae, Ancistosyllis bassi, Tharyx parvus, Megalomma pigmentum.*
Preference for sand and silty sand: *Prionospio pinnata, Magelona californica, Telepsavus costarum.*
Preference for sand, silty sand, sandy silt: *Haploscoloplos elongatus, Praxillella affinis pacifica.*
Preference for sandy silt: *Prionospio pygmaeus.*
Preference for silty sand and sandy silt: *Capitata ambiseta.*
Preference for sandy silt and silt: *Onuphis zebra, Prionospio cirrifera.*
Preference for silt: *Aricidea rosea, Cossura candida.*
No apparent preference for specific sediments: *Aglaophamus dicirrus, Glycinde armigera, Polydora socialis plena, Heteroclymene glabra, Amaeana occidentalis, Euchone barnardi.*

These data indicate that the commonest species of polychaetes occur near sandy sediments. Furthermore, the finer the sediments the fewer the number of species encountered, both with respect to percent occurrence and the average number of specimens encountered per station.

Substrate domination by polychaetes. — Dominant species were defined as those represented by the largest number of specimens. These were compared for substrate

preferences. Five species constituted the dominant bay species during the April 1962 survey and nine species in October 1963. Only two species, *Prionospio cirrifera* and *Tharyx parvus*, were dominant in both surveys.

April 1962. — Sandy substrates: *Capitata ambiseta, Chaetozone corona, Praxillella affinis pacifica, Haploscoloplos elongatus, Spiophanes bombyx.* Silty sands: *C. ambiseta, H. elongatus, Aricidea rosea,* and *Tharyx parvus.* Sandy silts and silts: *A. rosea, C. ambiseta.* Silts: *Prionospio cirrifera, A. rosea,* and *C. ambiseta.*

October 1963. — Sandy substrate: *Prionospio pinnata, Armandia bioculata, Glycera tesselata.* Silty sands: *P. pinnata, Magelona californica, Prionospio cirrifera, Tharyx parvus.* Sandy silts: *Aglaophamus dicirris, Onuphis zebra, P. cirrifera.* Silts: *O. zebra, Cossura candida.*

Seasonal Differences. — Of 46,570 polychaetes taken during this study, 39,470 were collected in April 1962 and 7,100 in October 1963. The cause of this 89 per cent reduction in numbers of specimens is unknown, but some explanations can be offered. Summer water temperatures may be too high for this primarily temperate fauna. Median surface-water temperatures were 18.2C in April 1962 and 25.9C in October 1963. Greater extremes have been measured (Barnard, personal communication). Minima of 15C (possibly 12C) were measured in February and 29.8C in August during the years 1962 and 1963. A second possibility is that red tides might lower the dissolved oxygen below minimal values for survival of benthic animals. Such a phenomenon has occurred in Alamitos Bay, California (Reish 1963b). Collections of benthic animals in Alamitos Bay were made before and after an extensive bloom of the dinoflagellate, *Gonyaulax polyhedra* Stein. Approximately 50 per cent of the animals, the majority of which were polychaetes, were eliminated; of the remaining species nearly two-thirds decreased in abundance. Dense red tides were observed in Bahía de los Angeles by Dr. J. L. Barnard in March 1961, April 1962, and April 1963, but whether they contributed to the summer decrease in the fauna is unknown. The causative organism of these red tides in Bahía de los Angeles is unknown.

The number of specimens per station was plotted for both surveys (Figs. 2, 3). In both surveys the largest populations occurred in the inner middle part of the bay and along the north shore. A marked decrease in polychaete numbers was evident in the October survey. In April 1962, samples ranged from 66 to 1722 individuals (median 500), but in October 1963 only 14 to 425 (median 46) were collected. The decrease in the number of species collected, from 98 to 90, was not as noticeable. Considering only the 75 species in which ten or more individuals were collected, the inter-sample variation can be classified as follows.

Species presently only in April 1963 (6). — *Eumida sanguinea, Syllidia liniata, Pionosyllis gigantia, Platynereis bicanaliculata, Orbinia johnsoni, Polycirris perplexus.*

Species which decreased from April 1962 to October 1963 (41). — *Eteone dilatae, Paranaitis polynoides, Microphthalmus riojai, Ancistrosyllis bassi, Langerhansia heterochaeta, Ceratonereis mirabilis, Nereis procera, Pilargis hamatus, Aglaophamus dicirris, Nephtys panamensis, Glycera americana, Lumbrineris minima, Haploscoloplos elongatus, Aricidea rosea, Paraonis gracilis oculata, Nerinides acuta, Polydora socialis plena, Prionospio cirrifera, P. pygmaeus, Spiophanes bombyx, S. missionensis, Telepsavus costarum, Caulleriella alata, Chaetozone corona, Tharyx parvus, T. tesselata, Polyophthalmus pictus, Travisia gigas, Anotomastus gordiodes, Capitata ambiseta, Notomastus (Clistomastus) tenuis, Heteroclymene glabra, Maldane sarsi, Praxillella affinis pacifica, Amphisamytha bioculata, Amphicteis scaphobranchiata, Amaeana occidentalis, Terebellides stroemi, Chone mollis, Euchone barnardi, Megalomma pigmentum.*

Species present only in October 1963 (3). — *Nereis riisei, Laonice cirrata, Fabricia limnicola.*

Figure 2. — Map of Bahia de los Angeles showing the number of specimens of polychaetes collected per station in April 1962.

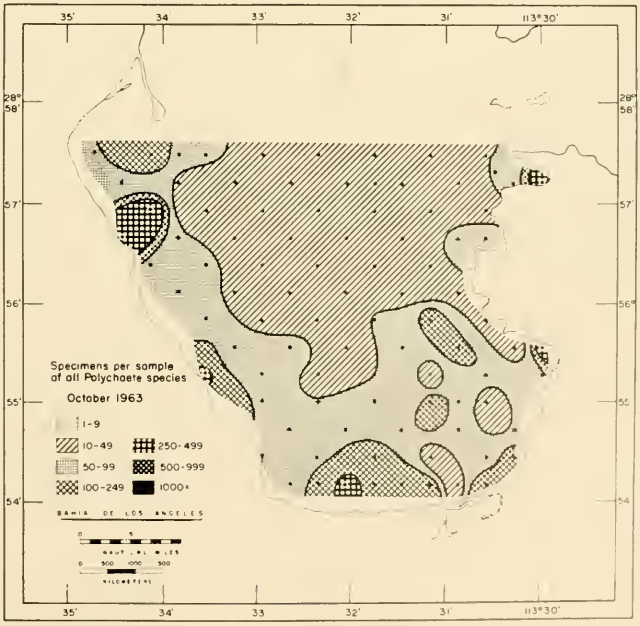

Figure 3. — Map of Bahia de los Angeles showing the number of specimens of polychaetes collected per station in October 1963.

Species which increased from April 1962 to October 1963 (16). — *Pareulepis fimbriata, Chloeia viridis, Pareurythoe californica, Ophiodromus pugettensis, Exogone lourei, Eunice vittata, Protodorvillea gracilis, Prionospio malmgreni, P. pinnata, Magelona californica, Cirriformia spirabrancha, Armandia bioculata, Owenia fusiformis collaris, Pista cristata.*

Species in approximate equal numbers in both surveys (9). — *Glycinde armigera, Onuphis zebra, Phyllo felix, P. nudus, Scoloplos acmeceps, Aricidea uschakovi, Poecilochaetus johnsoni, Cossura candida, Pherusa neopapillata.*

Therefore, more species were reduced or eliminated from April 1962 to October 1963 than the reverse. If this reduction is an annual phenomenon, then repopulation — presumably from the deeper waters of the gulf — must be rapid, judged by the large samples obtained during the April survey. Bahía de los Angeles specimens are smaller than those of the same species from southern California. Possibly many are immature, but some with ova developing within the coelom were observed. A study of the causes of the reduction and subsequent increase in the fauna should be undertaken.

In the following list, the number of stations in at which each species was collected, and the number of specimens collected (in parentheses) is given for each survey. The detailed station listing of species and numbers of specimens has been filed with the American Documentation Institute, Auxillary Publication Service, Library of Congress, Washington, D.C. Holotypes and paratypes, and additional specimens of the new species have been deposited in The United States National Museum; the remaining material studied is in the author's collection.

SYSTEMATIC LIST

Family Polynoidae

Lepidonotus purpureus Potts

Lepidonotus purpureus. Potts, 1910: 334; Hartman, 1951: 91. *Lepidonotus hedleyi* Benham. Hartman, 1939a: 40.
Material. — April 1962: 3 (4).
Ecology. — Two specimens from sandy substrates, two from silt-sand mixture.
Distribution. — Indian Ocean, Australia, South Pacific, Gulf of California.

Panthalis pacifica Treadwell

Panthalis pacifica. Treadwell, 1914: 184; Hartman, 1939a: 87-88.
Material. — April 1962: 2 (2).
Ecology. — Both specimens from silty substrates.
Distribution. — Southern California to Baja California, questionably Panama (Hartman, 1939a).

Polyodontes frons Hartman

Polyodontes frons. Hartman, 1939a: 84-86.
Material. — April 1962: 1 (1). October 1963: 1 (1).
Distribution. — Previously known only from type collected from Pinas Bay, Panama.

Family Sigalionidae

Stenelanella uniformis Moore

Stelelanella uniformis. Moore, 1910: 391-395; Hartman, 1939a: 69-70.
Material. — October 1963: 3 (9).
Ecology. — Eight specimens from sandy substrates, one from silty sand.
Distribution. — Southern California to Ecuador. This is the first report from the Gulf of California.

Stenolepis fimbriarum (Hartman)

Leanira fimbriarum. Hartman, 1939a: 70-72. *Stenolepis fimbriarum.* Hartman, 1965b: 15.
Material. — April 1962: 5 (8).
Ecology. — Three stations sandy, two silty.
Distribution. — Southern California to Ecuador; Gulf of California.

Thalenessa lewisii (Berkeley and Berkeley)

Sigalion lewisii. Berkeley and Berkeley, 1939: 226-228. *Ensigalion hancocki.* Hartman, 1939a: 59-60. *Thalenessa lewisii.* Hartman, 1959: 122.
Material. — April 1962: 2 (8); October 1963: 1 (1).
Ecology. — Eight specimens taken from sandy substrates, and one from silty sand.
Distribution. — Gulf of California south to Ecuador and Galapagos Islands.

Family Pareulepidae

Pareulepis fimbriata (Treadwell)

Eulepis fimbriata. Treadwell, 1901: 190. *Pareulepis fimbriata*. Hartman, 1939a: 79-80; 1961: 54-55.
Material. — April 1963: 13 (29); October 1963: 21 (37).
Ecology. — Shows a slight preference for sandy sediments (Table 2).
Distribution. — Southern California to Ecuador; West Indies; New Caledonia; Madgascar.

Family Chrysopetalidae

Paleanotus bellis (Johnson)

Heteropale bellis. Johnson, 1897: 163. *Paleanotus bellis*. Hartman, 1961: 57-58.
Material. — April 1962: 1 (1); October 1963: 1 (1).
Ecology. — Silty sands.
Distribution. — British Columbia to western Mexico. This is the first report from the Gulf of California.

Family Amphinomidae

Chloeia viridis Schmarda

Cloeia viridis. Schmarda, 1861: 144. Hartman, 1940: 205.
Material. — April 1962: 5 (8); October 1963: 5 (18).
Ecology. — Occurs in all types of substrates.
Distribution. — West Indies, Gulf of California, south to Panama, Galapagos Islands, and Cocos Islands.

Pareurythoe californica (Johnson)

Eurythoe californica Johnson, 1897: 159. *Pareurythoe californica*. Hartman, 1940: 203-204; 1961: 11.
Material. — April 1962: 3 (4); October 1963: 4 (13).
Ecology. — Preferred silty sand substrates.
Distribution. — Central and southern California; the distribution is extended into the Gulf of California.

Family Phyllodocidae

Anaitides mucosa (Oersted)

Phyllodoce mucosa. Oersted, 1843: 31. *Anaitides mucosa*. Hartman, 1961: 12.
Material. — April 1962: 4 (4).
Ecology. — Taken from various substrates.
Distribution. — Cosmopolitan. This is the first report from the Gulf of California.

Anaitides williamsi Hartman

Anaitides williamsi. Hartman, 1936: 126; Reish, 1963: 408.
Material. — April 1962: 3 (5).
Ecology. — Sandy sediments.
Distribution. — Oregon to Pacific Baja California. This is the first report from the Gulf of California.

Eteone dilatae Hartman

Eteone dilatae. Hartman, 1936: 130-131; Reish, 1963a: 408.
Material. — April 1962: 35 (85); October 1963: 7 (14).
Ecology. — Preference for silty sands (Table 2), which agrees with the finding of Hartman (1961) and Reish (1963a).
Distribution. — California and San Quintin Bay. This is the first report from the Gulf of California.

Enmida sanguinea (Oersted)

Eulalia sanguinea. Oersted, 1843: 28. *Enmida sanguinea*. Hartman, 1961: 13.
Material. — April 1962: 17 (30).
Ecology. — This species was taken from a variety of substrates.
Distribution. — Cosmopolitan. Rioja (1947a) reported this species from La Paz.

Paranaitis polynoides (Moore)

Anaitis polynoides. Moore, 1909b: 339. *Paranaitis polynoides*. Hartman, 1961: 13.
Material. — April 1962: 16 (18); October 1963: 1 (1).
Ecology. — Specimens collected from a variety of substrates.
Distribution. — British Columbia to southern California. The distribution is extended into the Gulf of California.

Family Typhloscolecidae

Typhloscolex mulleri Busch

Typhloscolex mulleri. Busch, 1851: 115; Tebble, 1960: 231-236.
Material. — October 1963: 1 (1).
Remarks: — *Typhloscolex mulleri* is a pelagic cosmopolitan species. Presumably, this specimen was collected while the orange-peel bucket was being brought to the surface.

Family Hesionidae

Genus *Microphthalmus* Mecznikow, 1865, emended.

Type: *Microphthalmus sczelkowii* Mecznikow, 1865.

Remarks. — All known species of the genus possess three antennae and a pygidial plate (posterior end unknown in M. *aciculata* Hartman-Schröder, (1962a). Since the pygidial plate is distinctive to this genus of hesionids, the generic diagnosis of *Microphthalmus* is emended to include species with two antennae as well as three antennae

Diagnosis. — Prostomium with two or three frontal antennae, a pair of small ventral palpi; eyes present or absent; segments 1 to 3 each with a pair of dorsal and ventral tentacular cirri, no setae; parapodia unequally a single simple notoseta; dorsal and ventral cirri short and digitiform; neurosetae compound; pygidium with an expanded plate and two dorsal anal cirri.

Microphthalmus riojai, new species

Figure 4, a-f

Material. — Stations, April 1962: 5 (12); October 1963: 3 (5).

Description. — Length up to 3 mm; width including setae up to 0.2 mm; setigerous segments up to 30; prostomium and dorsal surface with reddish brown pigment; prostomium (Fig. 4a) trapezoidal in shape, widest posteriorly; two eyes at the posterior-lateral margin; a pair of antennae at the anterior margin of the prostomium; a pair of simple ventral palpi, nature of proboscis unknown; no jaws seen; segments 1 to 3 asetigerous, with 6 pairs of long tentacular cirri; parapodial lobes unequally biramous (Fig. 4c), neuropodial lobe conical in shape; one simple, curved lyrate notoseta (Fig. 4d) per lobe, each provided with 8 teeth; 4 to 6 compound neuroseta per lobe (Fig. 4e, f), each terminate in a delicate bidentate tip; pre-anal segment asetigerous, provided with a pair of dorsal and ventral knob-shaped cirri; pygidial plate (Fig. 4b) broadly concave with no indication of a bilobed condition; anal cirri extend beyond the margin of the anal plate.

Remarks. — Ten species are previously known to belong to this genus, three of which were recently described from the Pacific side of South America by Hartmann-Schröder (1962a, b). *Microphthalmus riojai* differs from the other species by the absence of the median unpaired antennae. It belongs to that group of species characterized by the presence of lyrate setae in the notopodium. Other species known to possess this type of notosetae include *M. sczelkowii* Mecznikow, (1865), *M. s. murmanica* Zachs (*in* Uschakov, 1955), and *M. urofimbriata* Alikunhi (1943.)

Ecology. — Associated with the coarser sediments; eleven specimens were taken from a sandy substrate and six from silty sand.

Type material. — The holotype and 7 paratypes have been deposited in the U. S. National Museum.

Type locality. — Bahía de los Angeles, Gulf of California, Baja California. This species is named in honor of Dr. Enrique Rioja, in recognition of his contribution to the knowledge of Mexican polychaetes.

Ophiodromus pugettensis (Johnson)

Podarke pugettensis. Johnson, 1901: 395; Rioja, 1947a: 202. *Ophiodromus pugettensis*. Hartman, 1961: 67-68; Reish, 1963a: 423.

Material. — April 1962: 29 (46); October 1963: 19 (101).

Ecology. — Found on sandy or silty substrates (Table 2).

Distribution. — Japan and from British Columbia to Peru.

Oxydromus arenicolus glabrus Hartman

Oxydromus arenicolus glabrus. Hartman, 1961: 68-69.

Material. — April 1962: 4 (9).

Ecology. — Specimens from silty sands or sandy silts.

Distribution. — Previously known from California. The distribution is extended into the Gulf of California.

Oxydromus brunnea Hartman

Oxydromus brunnea. Hartman, 1961: 69-70.

Material. — April 1962: 2 (2).

Ecology. — Sand and silty sand.

Distribution. — Southern California; the distribution is extended into the Gulf of California.

Syllidia liniata Hartmann-Schröder

Syllidia liniata. Hartmann-Schröder, 1962a: 115-116.

Material. — April 1962: 8 (55); October 1963: 3 (6).

Ecology. — Silty sands at most stations; however, 30 specimens were taken at a station consisting of sands.

Distribution. — Peru; the distribution is extended into the Gulf of California.

Family Pilargidae

Ancistrosyllis bassi Hartman

Ancistrosyllis bassi. Hartman, 1947b: 501-504.

Material. — April 1962: 4 (7); October 1963: 35 (52).

Ecology. — *A. bassi* showed a slight preference for silty sand sediments (Table 2).

Distribution. — Known from California and Florida; the distribution is extended into the Gulf of California.

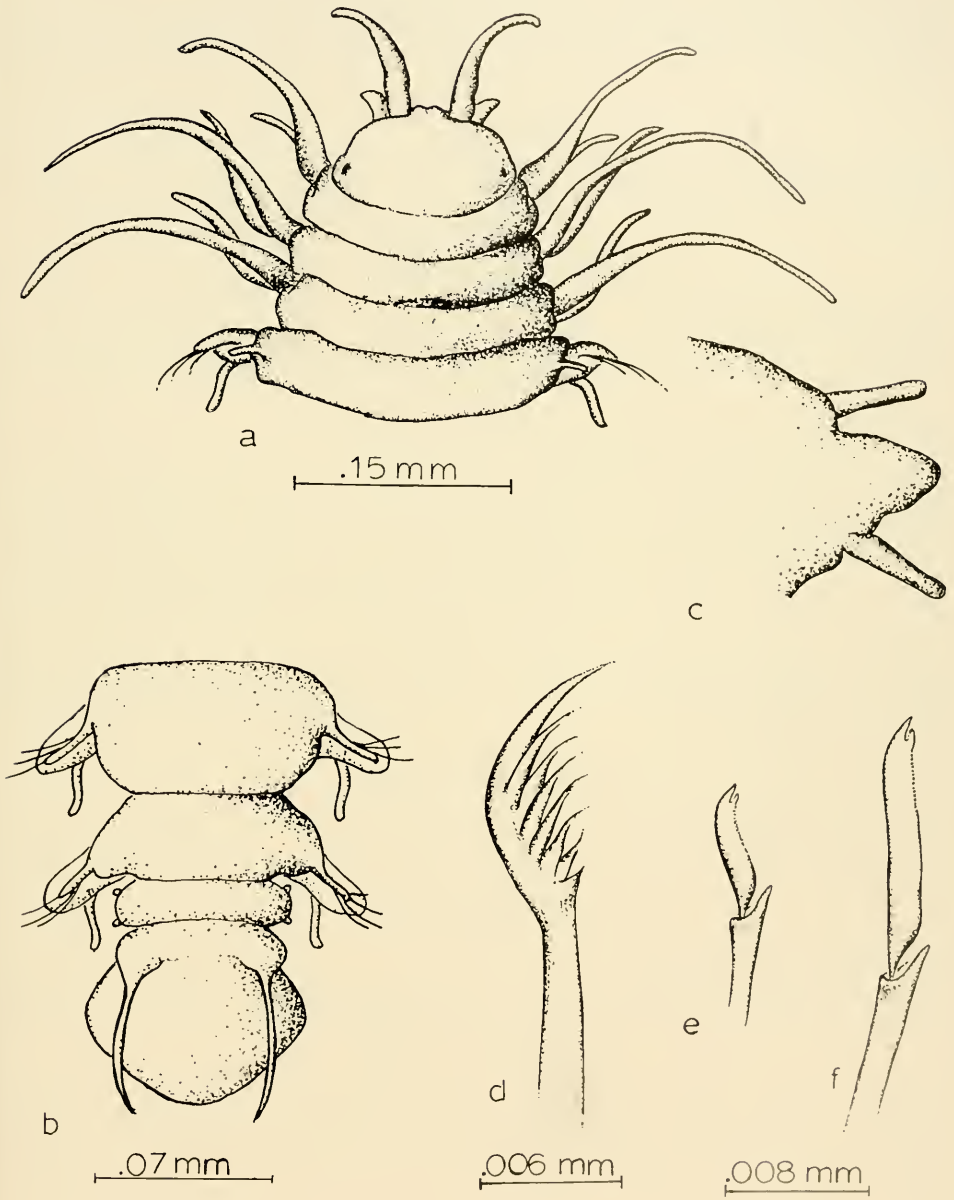

Figure 4. — **Microphthalmus riojai**, n. sp.: a, anterior end, dorsal view; b, posterior end, dorsal view; c, parapodium from mid-region, magnification as figure b; d, lyre seta from notopodium; e-f, compound neurosetae from neuropodium.

Loandalia fauveli Berkeley and Berkeley

Loandalia fauveli. Berkeley and Berkeley, 1941: 30-31, pl. 5, figs. 4-6.
Material. — April 1962: 4 (4); October 1963: 5 (5).
Ecology. — Taken from all substrate types.
Distribution. — Previously known only from southern California; the distribution is extended into the Gulf of California.

Pilargis hamatus Hartman

Pilgaris hamatus. Hartman, 1960: 88-89.
Material. — April 1962: 26 (63); October 1963: 9 (16).
Ecology. — *Pilargis hamatus* showed a preference for either sands or silty sands (Table 2).
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Family Syllidae

Brania limbata (Claparède)

Grubea limbata. Claparède, 1868: 52. *Brania limbata.* Reish, 1959a: 79; Hartmann-Schröder, 1962b: 103.
Material. — April 1962: 2 (3).
Ecology. — Sandy sediments.
Distribution. — Known from Europe, southern California, and Chile. This is the first report from the Gulf of California.

Exogone lourei Berkeley and Berkeley

Exogone lourei. Berkeley, 1938: 44-47; Reish, 1959a: 80.
Material. — April 1962: 5 (13); October 1963: 11 (231).
Ecology. — This species showed a preference for either sandy or silty sand sediments; 161 specimens were taken from a station composed of silty sands.
Distribution. — This species is known from British Columbia to southern California and Acapulco, Mexico. The distribution is extended into the Gulf of California.

Langerhansia heterochaeta (Moore)

Syllis (Ehlersia) heterochaeta. Moore, 1909b: 322-325. *Langerhansia heterochaeta.* Hartman, 1959: 210, 1961: 16.
Material. — April 1962: 21 (70); October 1963: 16 (40).
Ecology. — This species showed preference for either a sandy or silty sand substrates (Table 2).
Distribution. — Known from British Columbia to southern California. This report extends its distribution into the Gulf of California.

Odontosyllis phosphorea Moore

Odontosyllis phosphorea. Moore, 1909b: 327-329; Hartman, 1961: 76-77.
Material. — October 1963: 1 (1).
Ecology. — Sandy sediments.
Distribution. — British Columbia to southern California; this is the first report of the species from the Gulf of California.

Pionosyllis gigantea Moore

Pionosyllis gigantea. Moore, 1908: 325-328; Hartman, 1961: 16.
Material. — April 1962: 8 (27).
Ecology. — All but 3 specimens from stations possessing sandy sediments.
Distribution. — Known from British Columbia to California; the distribution is extended into the Gulf of California.

Sphaerosyllis erinaceus Claparède

Sphaerosyllis erinaceus. Claparède, 1863: 45; Rioja, 1943: 211-214; Day, 1954: 13-14; Pettibone, 1963: 135-136.
Material. — April 1962: 1 (1); October 1963: 1 (6).
Ecology. — Substrate sand or silty sands.
Distribution. — Northern Hemisphere and Tristan de Cunha; Rioja (1943) reported it from Acapulco; this is the first record from the Gulf of California.

Family Nereidae

Ceratonereis mirabilis Kinberg

Ceratonereis mirabilis. Kinberg, 1866: 170; Hartman, 1948: 71-72. *Nereis (Ceratonereis) mirabilis.* Fauvel, 1953: 200-201. *Ceratonereis singularis.* Treadwell, 1929: 1-3.
Material. — April 1962: 33 (68); October 1963: 9 (29).
Ecology. — Marked preference for sandy sediments (Table 2).
Distribution. — Cosmopolitan in warmer seas. Hartman (1948) referred *C. singularis* Treadwell from Carmen Island, Baja California to this species.

Nereis procera Ehlers

Nereis procera. Ehlers, 1868: 557; Reish, 1959a: 81-82.
Material. — April 1962: 27 (65); October 1963: 6 (16).
Ecology. — *Nereis procera* showed a slight preference for sandy substrates (Table 2).
Distribution. — British Columbia to southern California; the distribution is extended into the Gulf of California.

Nereis riisei Grube

Nereis riisei. Grube, 1857: 162; Hartman, 1940: 221-222; 1951: 46; Rioja, 1959: 225.
Material. — October 1963: 6 (11).
Ecology. — Nine specimens from sandy substrates; two from silty sands.
Distribution. — Known from the Gulf of California to Ecuador and Gulf of Mexico; the distribution within the Gulf of California is extended northward.

Platynereis bicanaliculata (Baird)

Nereis bicanaliculata. Baird, 1863: 109; *Platynereis bicanaliculata*. Hartman, 1954: 36-39.
Material. — April 1962: 4 (32).
Ecology. — The substrate was sandy at Station 130 where 29 specimens were collected. The other stations were composed of silty sands and sandy silts.
Distribution. — Western Canada to Baja California, Gulf of California, Hawaii, Australia, and possibly Peru (Hartmann-Schröder, 1962a).

Family Nephtyidae

Aglaophamus dicirris Hartman

Aglaophamus dicirris. Hartman, 1950: 122-124.
Material. — April 1962: 67 (822); October 1963: 84 (509).
Ecology. — Collected at 93 per cent of the stations sampled. Equally common on silty sand or sandy silt substrates (Table 2). As widespread but less abundant in October 1963 than in April 1962; the average number of specimens per station was only 6 (maximum 19) as compared to 12 (maximum 76). The population, especially reduced in the inner reaches of the bay.
Distribution. — Southern California to Panama; Gulf of California; North Carolina.

Nephtys panamensis Monro

Nephtys panamensis. Monro, 1928: 81-82; Hartman, 1940: 239-240; 1950: 101.
Material. — April 1962: 24 (147); October 1963: 3 (4).
Ecology. — Commonest on sandy substrates.
Distribution. — Gulf of California to Panama.

Family Glyceridae

Glycera americana Leidy

Glycera americana Leidy, 1855: 147-148; Hartman, 1950: 73-75.
Material. — April 1962: 21 (40); October 1963: 6 (18).
Ecology. — Taken most frequently from the sandy and silty sand bottoms.
Distribution. — Western Hemisphere, New Zealand, Australia.

Glycera robusta Ehlers

Glycera robusta Ehlers, 1868: 656-658; Hartman, 1950: 69-70.
Material. — April 1962: 2 (7).
Ecology. — Sandy sediments.
Distribution. — British Columbia to southern California and possibly Florida (Hartman, 1950). The distribution is extended into the Gulf of California.

Glycera tesselata Grube

Glycera tesselata Grube, 1863: 41-42; Hartman, 1950: 77-78; Imajima and Hartman, 1964: 165.
Material. — April 1962: 21 (69); Oct. 1963: 35 (658).
Ecology. — *Glycera tesselata* preferred sandy substrates (Table 2). Most specimens were collected in October 1963 and these were small and presumably immature worms.
Distribution. — British Columbia south to tropical Pacific, Japan, Indo-Pacific, Caribbean Sea, and Mediterranean Sea.

Family Goniadidae

Glycinde arminger Moore

Glycinde arminger Moore, 1911: 307-311; Hartman, 1950: 49-51.
Material. — April 1962: 57 (290); October 1963: 56 (342).
Ecology. — Widespread, in all substrates in both survey; most specimens from sandy benthos (Table 2). The increase in October 1963 reflects the extreme abundance of the species (225 individuals) at station 65. The largest sample in April 1962 was 18
Distribution. — British Columbia south to Galapagos Islands. The distribution is extended into the Gulf of California.

Goniada littorea Hartman

Goniada littorea Hartman, 1950: 23-26; Reish, 1963a: 425.
Material. — October 1963: 1 (1).
Ecology. — Silty sand.
Distribution. — Southern California to San Quintin Bay; the distribution is extended into the Gulf of California.

Family Onuphidae

Onuphis nebulosa Moore

Onuphis nebulosa Moore, 1911: 269-273; Hartman, 1944a: 75-78.
Material. — April 1962: 9 (23); Oct. 1963: 8 (44).
Ecology. — This species preferred coarser sediments.
Distribution. — Central California to Panama; this is the first report from the Gulf of California.

Family Onuphidae

Onuphis zebra Berkeley and Berkeley

Onuphis zebra Berkeley and Berkeley, 1939; 337-338; Hartman, 1944a: 71-72.
Material. — April 1962: 60 (746); Oct. 1963: 76 (566).
Ecology. — This was one of the commonest worms in the bay. It was present in all types of substrates, but it showed a preference for finer sediments. This species constructs a tube of silt. *Onuphis zebra* was widespread throughout the bay during both surveys; a slight drop in the population was noted in the October 1963 survey. The maximum April sample was 115; October. 23.
Distribution. — Punta Gorda, Baja California and Guatemala; the distribution is extended northward in the Gulf of California from near the vicinity of La Paz to Bahía de los Angeles.

Family Eunicidae

Eunice vittata (delle Chiaje)

Nereis vittata delle Chiaje, 1828: 195. *Eunice vittata*. Hartman, 1944a: 118.
Material. — April 1962: 1 (1); Oct. 1963: 3 (4).
Ecology. — Sands or silty sands.
Distribution. — Warmer waters of the Western Hemisphere from Bermuda to West Indies and Trinidad, from southern California to Panama, and many localities in the Gulf of California.

Nematonereis unicornis (Grube)

Lumbriconereis unicornis Grube, 1840: 80. *Nematonereis unicornis*. Fauvel, 1953: 249-250.
Material. — April 1962: 1 (5).
Ecology. — Sand.
Distribution. — Cosmopolitan in warmer seas; previously unknown from the Gulf of California.

Family Lumbrineridae

Lumbrineris erecta (Moore)

Lumbriconereis erecta. Moore, 1904: 490-492. *Lumbrineris erecta*. Hartman, 1944a: 149-150.
Material. — October 1963: 1 (1).
Ecology. — Sand.
Distribution. — Southern California to Panama, and Gulf of California.

Lumbrineris minima Hartman

Lumbrineris minima. Hartman, 1944a: 155-156; Reish, 1963a: 425-426.
Material. — April 1962: 57 (378). October 1963: 20 (53).
Ecology. — Commonest on coarser sediments (Table 2). This is similar to the ecology off southern California (Hartman, 1944a; Reish, 1959a), but unlike that at San Quintin Bay (Reish, 1963a).
Distribution. — Southern California and San Quintin Bay; the distribution is extended into the Gulf of California.

Family Arabellidae

Drilonereis nuda Moore

Drilonereis nuda. Moore, 1909a: 254-256; Hartman, 1944a: 178-179.
Material. — April 1962: 2 (2); October 1963: 3 (3).
Ecology. — Sands or sands and silts.
Distribution. — Central California to Panama. Fauvel (1943) reported it from the Gulf of California (locality unspecified).

Family Dorvilleidae

Protodorvillea gracilis (Hartman)

Stauronereis gracilis. Hartman, 1938: 100-101. *Dorvillea gracilis*. Hartman, 1944a: 189. *Protodorvillea gracilis*. Hartman, 1965b: 48.
Material. — April 1962: 7 (20). October 1963: 7 (132).
Ecology. — Of 152 specimens, 141 were taken from eight stations characterized by sandy sediments.
Distribution. — California; the distribution is extended into the Gulf of California.

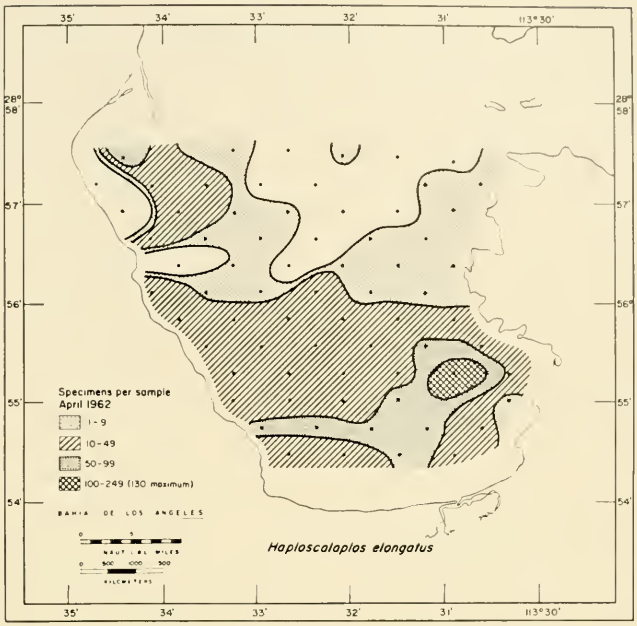

Figure 5. — Benthic distribution of *Haploscoloplos elongatus* in April 1962.

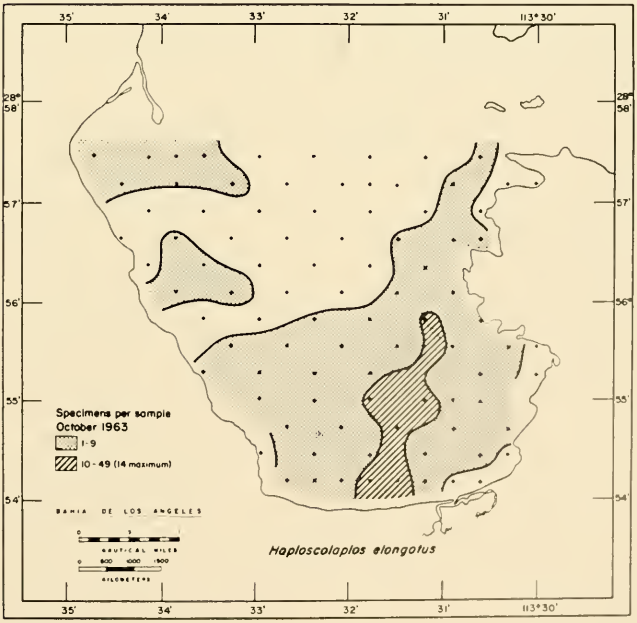

Figure 6. — Benthic distribution of *Haploscoloplos elongatus* in October 1963.

Family Orbiniidae

Haploscoloplos elongatus (Johnson)

Scoloplos elongata. Johnson, 1901: 412-413. *Haploscoloplos elongatus.* Hartman, 1957: 273-275; Reish, 1963a: 426; 1965: 140; Imajima and Hartman, 1964: 274.

Material. — April 1962: 58 (1470), October 1963: 54 (252).

Ecology. — Widespread, commonest on silty sandy (Table 2). Much reduced in October 1963, especially in inner part of bay (Figs. 5, 6).

Distribution. — Japan, Beaufort Sea to San Quintin Bay; the distribution is extended into the Gulf of California.

Orbinia johnsoni (Moore)

Aricia johnsoni. Moore, 1909a: 260-262; *Orbinia johnsoni.* Hartman, 1957: 257-260.

Material. — April 1962: 2 (4).

Ecology. — Sandy silts.

Distribution. — Central California to Costa Rica; previously unknown from the Gulf of California.

Phylo felix Kinberg

Phylo felix. Kinberg, 1866: 251-252; Hartman, 1957: 262-265.

Material. — April 1962: 10 (15); October 1963: 19 (17).

Ecology. — Taken from all substrate types.

Distribution. — California, Gulf of California, Brazil, Patagonia, East Falkland Island, and Antarctic Ocean.

Phylo nudus (Moore)

Aricia nuda. Moore, 1911: 311-315. *Phylo nudus.* Hartman, 1957: 268.

Material. — April 1962: 4 (7); October 1963: 6 (8).

Ecology. — Sands or a mixture of sands and silts.

Distribution. — Southern California and Burma; the distribution is extended into the Gulf of California.

Scoloplos acmeceps Chamberlin

Scoloplos acmeceps. Chamberlin, 1919b: 15-16; Hartman, 1957: 282-283.

Material. — April 1962: 3 (7); October 1963: 2 (6).

Ecology. — Sands or sands and silts.

Distribution. — Alaska to Mazatlan; this is the first report from the Gulf of California.

Family Paraonidae

Aricidea uschakowi Zachs

Aricidea uschakowi. Zachs, 1925: 1-3; Hartman, 1957: 321.

Material. — April 1962: 8 (176); October 1963: 24 (160).

Ecology. — Commonest on sand bottoms.

Distribution. — Russian Pacific Ocean to southern California; the distribution is extended into the Gulf of California.

Aricidea rosea, new species

Figures 7a-c, 8

Material. — April 1962: 53 (5534); October 1963: 12 (19).

Diagnosis. — Length to 7-8 mm; width 0.25 mm; to at least 70 setigerous segments; prostomium (Fig. 7a) triangular in shape and rounded anteriorly, without eyespots, the median antenna extends into the second setigerous segment; branchiae number 11 to 12 pairs, begin at setigerous segment 4 and extend to segment 15 or 16, third to ninth pair largest and may overlap with opposite member mid-dorsally; notopodia with ciriform notopodial post-setal lobe which is well developed throughout the length of the worm; neuropodium poorly developed; setae of notopodium of capillary type and distally pointed (Fig. 7b); capillary setae present in all neuropodial lobes; beginning at about segments 20-25 and to the posterior end four to six modified setae appear in the neuropodium (Fig. 7c); they are of the curved acicular type with a secondary tooth and a pointed hood.

Type material. — The holotype and paratypes have been deposited in the U. S. National Museum. The type locality is Bahía de los Angeles, Baja California, Mexico.

Remarks. — Hartman (1959b) listed nine species within the genus *Aricidea* (*Aricidea*) plus two additional species which were referred with question. Three additional species have since been described *A.* (*A.*) *lopezi ruba* Hartman (1963), *A. abranchiata* Hartman (1965a), and *A. neosuecica* Hartman (1965a). The different species of the genus may be conveniently separated from one another on the basis of the number of pairs of branchiae and the nature of the modified neuroseta. *Aricidea* (*A.*) *rosea* can be distinguished from the majority of the known species by the number of pairs of branchiae. There are 11 to 12 pairs in *A.* (*A.*) *rosea* and 9 to 11 in *A.* (*A.*) *lopezi ruba;* they differ, however, in the nature of their modified neuroseta.

Ecology. — This is one of the commonest polychaetes in Bahía de los Angeles; 22 of the 5352 specimens were collected in April 1962 (Fig. 15). The greatest concentration of *A. rosea* occurred in fine sediments in the middle part of the bay.

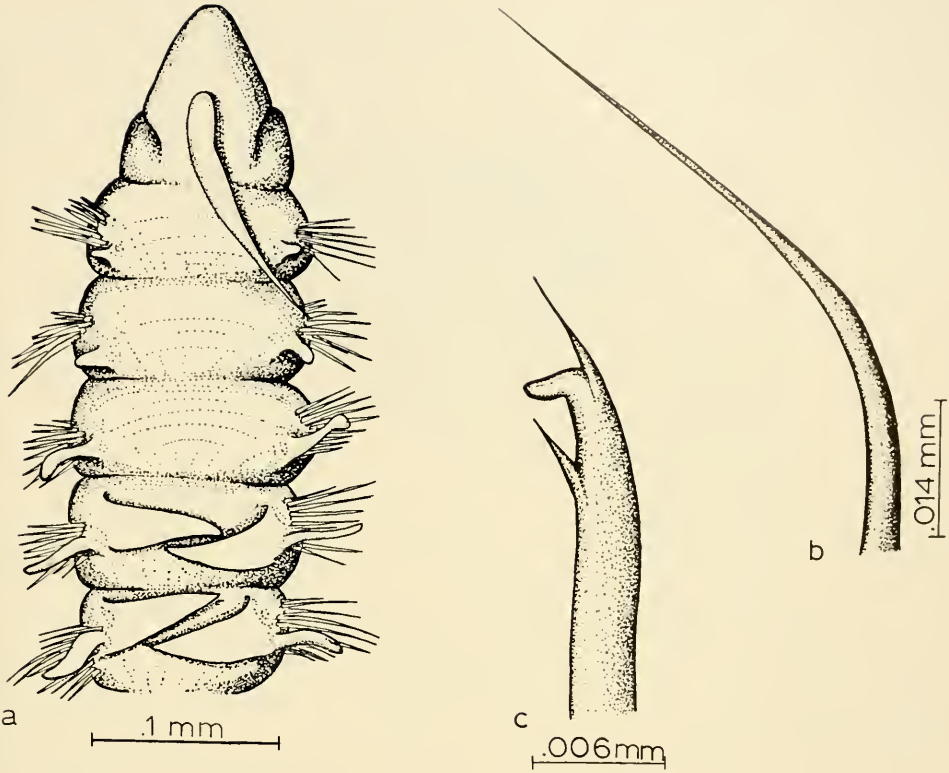

Figure 7 — Aricidea (*Aricidea*) rosea, n. sp.: a, anterior end, dorsal view; b, capillary setae from notopodium; c, modified seta from neuropodium.

Paradoneis lyra Southern

Paraonis (*Paraonides*) *lyra.* Southern, 1914: 94-95; Hartman, 1957: 334-335.
Paradoneis lyra. Hartman, 1965: 52.
Material. — October 1963: 1 (3).
Ecology. — Sand.
Distribution. — European waters and southern California; the distribution is extended into the Gulf of California.

Paraonis gracilis oculata Hartman

Paraonis gracilis oculata. Hartman, 1957: 331-332.
Material. — April 1962: 13 (80); October 1963: 10 (17).
Ecology. — Commonest in sands and silty sands.
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Family Spionidae

Laonice cirrata (Sars)

Nerine cirrata. Sars, 1851: 207; *Laonice cirrata.* Berkeley and Berkeley, 1952: 26; Imajima and Hartman, 1964: 281-282.
Material. — October 1963: 3 (10).
Ecology. — Silty sands.
Distribution. — Cosmopolitan; this is the first report from the Gulf of California.

Neriinides acuta (Treadwell)

Spio acuta. Treadwell, 1914: 199-201. *Neriinides acuta.* Hartman, 1941: 294-296; Reish 1959a: 86.
Material. — April 1962: 5 (7); October 1963: 2 (2).
Ecology. — Sands and from sand and silts.
Distribution. — Southern California; the distribution is extended into the Gulf of California.

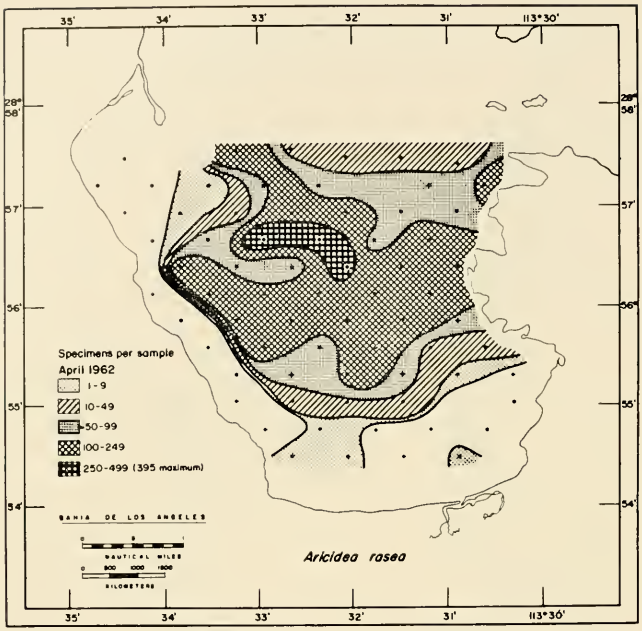

Figure 8 — Benthic distribution of Aricidea rosea in April 1962.

Nerinides maculata Hartman

Nerinides maculata. Hartman, 1961: 91-92; Reish, 1963a: 427.
Material. — October 1963: 1 (1).
Ecology. — Sand.
Distribution. — Southern California, San Quintin Bay, and the northern Gulf of California at San Felipe.

Nerinides pigmentata (Reish)

Spiophanes pigmentata. Reish, 1959c: 11-13. *Nerinides pigmentata.* Hartman, 1961: 92-93.
Material. — October 1963: 1 (2).
Ecology. — Silty sand.
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Polydora heterochaeta Rioja

Polydora heterochaeta. Rioja, 1939: 308-309.
Material. — October 1963: 3 (3).
Ecology. — Sand or silty sands.
Remarks. — Identified by Keith H. Woodwick.
Distribution. — Acapulco; the distribution is extended into the Gulf of California.

Polydora socialis plena Berkeley and Berkeley

Polydora socialis plena. Berkeley and Berkeley, 1936: 468-469; 1952: 22.
Material. — April 1962: 27 (81); October 1963: 22 (36).
Ecology. — Occurs on all substrate; commonest on sandy silts.
Remarks. — Identified by Keith H. Woodwick.
Distribution. — Alaska and British Columbia; the distribution is extended in the Gulf of California.

Prionospio cirrifera Wiren

Prionospio cirrifera. Wiren, 1883: 409; Fauvel, 1927: 62-63; Reish, 1959a: 87.
Material. — April 1962: 46 (623); October 1963: 62 (471).
Ecology. — This species was found at more stations, but not in greater numbers, in areas of finer sediments (Table 2). This relationship is similar to that found in Newport Bay, California (Reish, 1959a). Maximum count April, 1962, 48; October 1963, 34.
Distribution. — Europe, North Sea, Arctic Ocean, Bering Sea to southern California; the distribution is extended into the Gulf of California.

Prionospio longibranchiata, new species

Fig. 9 a-e

Material. — April 1962: 2 (2); October 1963: 5 (6).

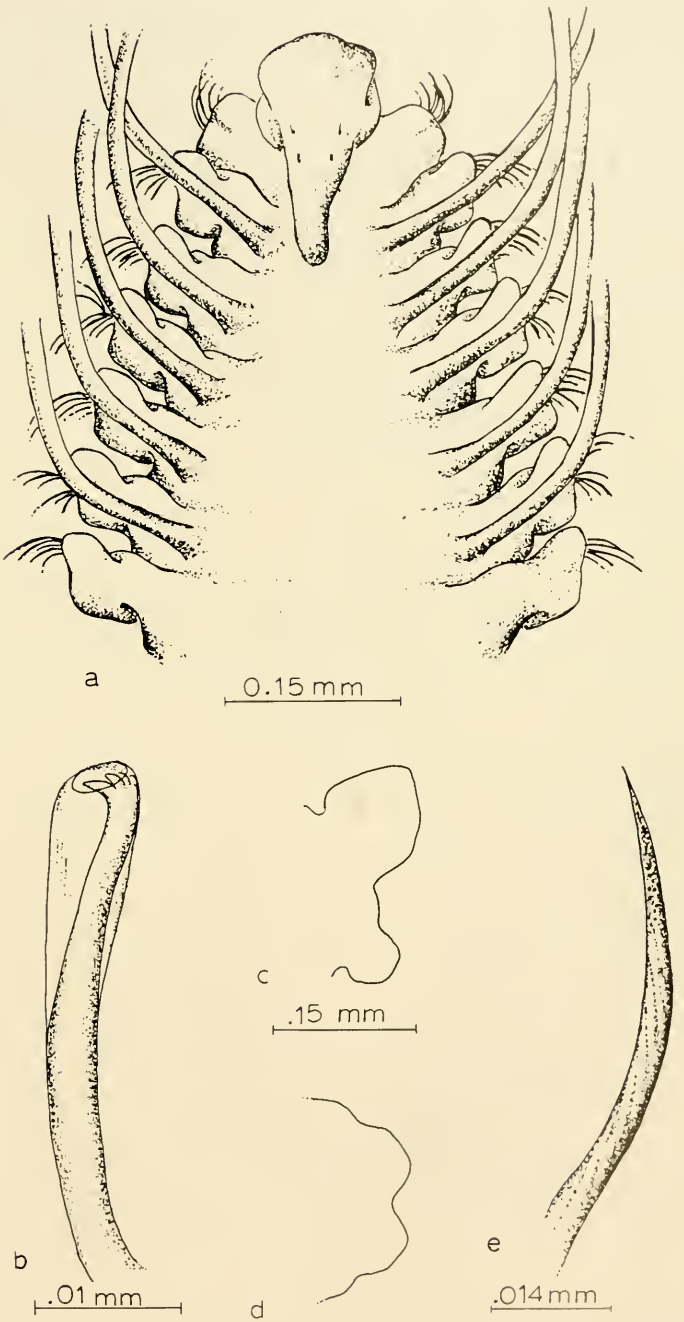

Figure 9. — **Prionospio longibranchiata**, n. sp.: a, anterior end, dorsal view; b, hooded hook from neuropodium; c, anterior parapodium; d, posterior parapodium, magnification as figure c; e, capillary seta from posterior inferior neuropodium.

Diagnosis. — Length of holotype 5 mm; width 0.2 mm; 37 setigerous segments; incomplete specimens as long as 12 mm, width 0.4 mm, 55 setigerous segments; prostomium (Fig. 9a) longer than broad, slightly rounded and expanded anteriorly, tapers posteriorly to second setigerous segment; peristomium prolonged anteriorly as lateral lobes to prostomium; palps broken off; 4 eyes equal in size with anterior pair farther apart; 5 pairs of long, cirriform branchiae, some partially broken with the longest extending to segment 20; all setigerous segments biramous; anterior segments with only capillary setae; hooded hooks from setigerous segment 17 in neuropodium, 21 in notopodium; hooded hooks (Fig. 9b) consist of one large tooth at right angles to shaft and 3 smaller teeth, hood as indicated in Fig. b; details of anterior and mid-body parapodial lobes shown in Fig. 9 c, d; pygidium with an unpaired longer cirrus and two shorter ones.

Remarks. — Thirty species are known previously from the genus *Prionospio* Malmgren (Hartman, 1959b; Hartmann-Schröder, 1962a, b; Laubier, 1962). *Prionospio longibranchiata* belongs to the group possessing only cirriform branchiae, but can be distinguished by the number and nature of the branchiae. *Prionospio cirrifera* Wiren (1883), cosmopolitan in distribution, has from 6 to 12 pairs of short branchiae. *Prionospio polybranchiata* Fauvel (1953), known from India, has 5 pairs of long branchiae, which resemble those of *P. longibranchiata,* and at least 35 pairs of shorter branchiae. *Prionospio heterobranchia* Moore (1907), from Massachusetts, *P. h. texana* Hartman (1951a) from Texas, and *P. h. newportensis,* Reish (1959c), from California, all have 5 pairs of branchiae, but the first, fourth, and fifth pairs are pinnate in all three species.

Type material. — The holotype and paratypes have been deposited in the U. S. National Museum. Type locality Bahía de los Angeles Baja California, Mexico.

Prionospio malmgreni Claparède

Prionospio malmgreni. Claparède, 1868: 333; Pettibone, 1954: 282-284.
Material. — April 1962: 7 (19); October 1963: 15 (59).
Ecology. — Sands or sandy silts. In San Quintin Bay, *P. malmgreni* was more abundant in finer sediments (Reish, 1963a).
Distribution. — Northern Hemisphere and South Africa; this is the first report from the Gulf of California.

Prionospio pinnata Ehlers

Prionospio pinnata. Ehlers, 1901; 163-164; Hartman, 1960: 114-115.
Material. — April 1962: 36 (252); October 1963: 61 (755).
Ecology. — Commonest on sand and silty sands.
Distribution. — Cosmopolitan; this is the first report from the Gulf of California.

Prionospio pygmaeus Hartman

Prionospio pygmaeus. Hartman, 1961: 93-95; Reish, 1963a: 427.
Material. — April 1962: 51 (876); October 1963: 4 (9).
Ecology. — All substrates (Table 2).
Distribution. — Southern California, San Quintin Bay; the distribution is extended into the Gulf of California.

Pseudopolydora reishi Woodwick

Pseudopolydora reishi. Woodwick, 1964: 152.
Material. — October 1963: 2 (4).
Ecology. — Silt and silty sands.
Remarks. — Specimens identified by Keith H. Woodwick.
Distribution. — This species was recently described from Eniwetok Atoll, Marshall Islands; the distribution is extended into the Gulf of California.

Spiophanes bombyx (Claparède)

Spio bombyx. Claparède, 1870: 485. *Spiophanes bombyx.* Berkeley and Berkeley, 1952: 22-24.
Material. — April 1962: 20 (427); October 1963: 3 (8).
Ecology. — Occurred almost exclusively in sandy sediments.
Distribution. — Cosmopolitan; this is the first report of the species from the Gulf of California.

Spiophanes missionensis Hartman

Spiophanes missionensis. Hartman, 1941: 296-298; Reish, 1963a: 427.
Material. — April 1962: 9 (12); October 1963: 1 (1).
Ecology. — Taken from all substrates.
Distribution. — Southern California, San Quintin Bay; the distribution is extended into the Gulf of California.

Family Magelonidae

Magelona californica Hartman

Magelona californica. Hartman, 1944c: 320-321; Reish, 1963a: 427.
Material. — April 1962: 14 (119); October 1963: 30 (537).
Ecology. — All specimens but one from sand or silty sands. Present at 73 per cent of the sandy stations but only 30 per cent of the silty sand stations (Table 2).
Distribution. — Southern California. San Quintin Bay; the distribution is extended into the Gulf of California.

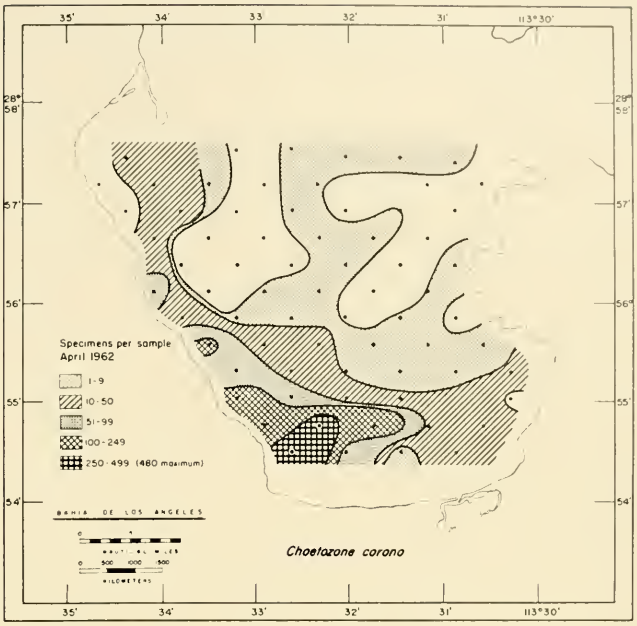

Figure 10. — Benthic distribution of *Chaetozone corona* in April 1962.

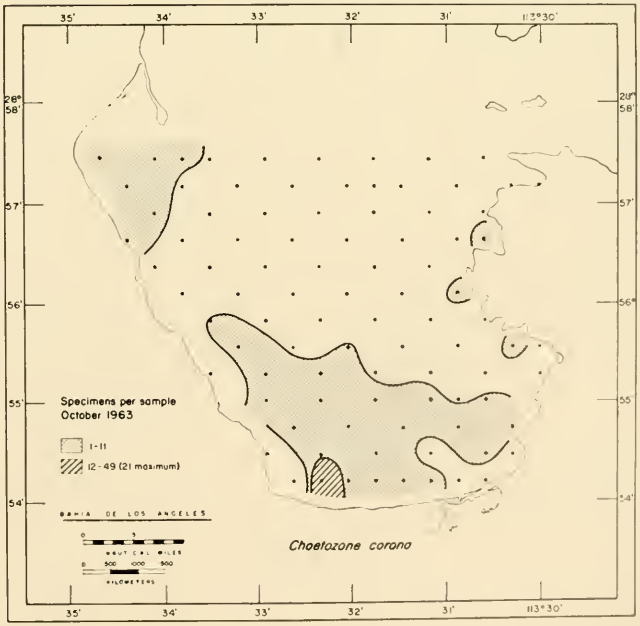

Figure 11. — Benthic distribution of *Chaetozone corona* in October 1963.

Family Disomidae

Poecilochaetus johnsoni Hartman

Poecilochaetus johnsoni. Hartman, 1939b: 164-166.
Material. — April 1962: 5 (6); October 1963: 3 (5).
Ecology. — Primarily sandy stations.
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Family Chaetopteridae

Telepsavus costarum Claparède

Telepsavus costarum. Claparède, 1868: 340; Berkeley and Berkeley, 1952: 63; Hartman, 1961: 31.
Material. — April 1962: 43 (433); October 1963: 24 (47).
Ecology. — Commonest on coarser sediments, but present at a few stations with sandy silt and silts.
Distribution. — Cosmopolitan; this is the first report from the Gulf of California.

Family Cirratulidae

Acrocirrus crassifilis Moore

Acrocirrus crassifilis. Moore, 1923: 188-190; Hartman, 1961: 31.
Material. — October 1963: 2 (5).
Ecology. — Sand or silty sands.
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Caulleriella alata (Southern)

Chaetozone alata. Southern, 1914: 112-113; *Caulleriella alata*. Hartman, 1961: 108.
Material. — April 1962: 10 (232); October 1963: 9 (21).
Ecology. — Preference for sand and silty sands.
Distribution. — Ireland and from British Columbia to southern California; the distribuiton is extended into the Gulf of California.

Chaetozone corona Berkeley and Berkeley

Chaetozone spinosa. Moore, var. *corona* Berkeley and Berkeley, 1941: 45-46; *Chaetozone corona*. Reish, 1959a: 89; Hartman, 1961: 109-110.
Material. — April 1962: 49 (2112); October 1963: 32 (133).
Ecology. — This species was eliminated from the outer part of the bay and was reduced in the inner reaches of the bay in October 1963 (Figs. 10, 11).
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Cirriformia spirabrancha (Moore)

Cirratulus spirabranchus. Moore 1904: 492-493; *Cirriformia spirabrancha*. Hartman, 1944b: 263.
Material. — April 1962: 2 (2); October 1963: 4 (20).
Ecology. — Sands or sand and silt mixture.
Distribution. — California; the distribution is extended into the Gulf of California.

Cossura candida Hartman

Cossura candida. Hartman, 1955: 44-45; Reish, 1963a: 428.
Material. — April 1962: 40 (341); October 1963: 42 (333).
Ecology. — *C. candida* was found at a larger number of stations and in greater abundance with increasing fineness of the sediment (Table 1). A similar ecology has been reported at San Quintin Bay (Reish 1963a). About equal numbers were taken in both surveys.
Distribution. — Southern and Lower California; the distribution is extended into the Gulf of California.

Tharyx parvus Berkeley

Tharyx multifilis parvus. Berkeley, 1929: 307, *Tharyx parvus*. Hartman, 1961: 113.
Material. — April 1962: 58 (1262); October 1963: 47 (520).
Ecology. — *T. parvus* showed a preference for the silty sands. About twice as many specimens were taken in April 1962 than October 1963; the reduction in the population occurred largely in the outer reaches of the bay (Figs. 12, 13).
Distribution. — British Columbia to southern California; the distribution is extended into the Gulf of California.

Tharyx tesselata Hartman

Tharyx tesselata. Hartman, 1960: 126-127; 1961: 113.
Material. — April 1962: 14 (62); October 1963: 3 (3).
Ecology. — Sands, silty sands and sandy silts.
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Family Flabelligeridae

Pherusa neopapillata Hartman

Pherusa neopapillata. Hartman, 1961: 121-122.
Material. — April 1962: 10 (12); October 1963: 6 (10).
Ecology. — All sediment types.
Distribution. — Southern California; the distribution is extended into the Gulf of California.

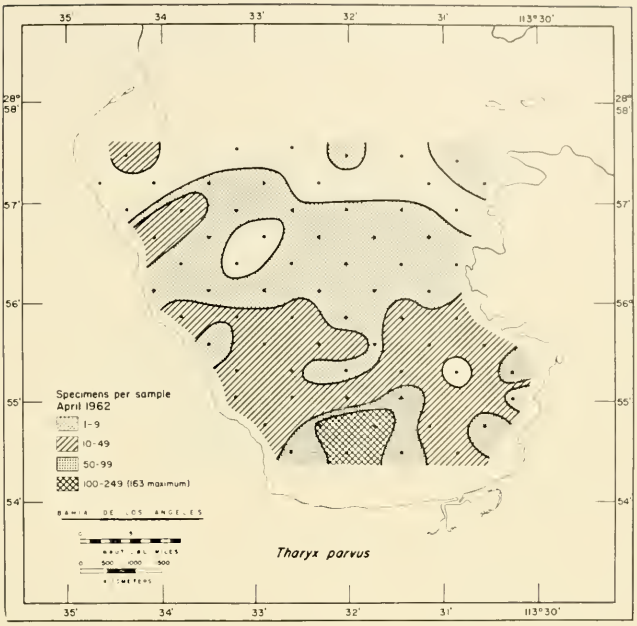

Figure 12. — Benthic distribution of *Tharyx parvus* in April 1962.

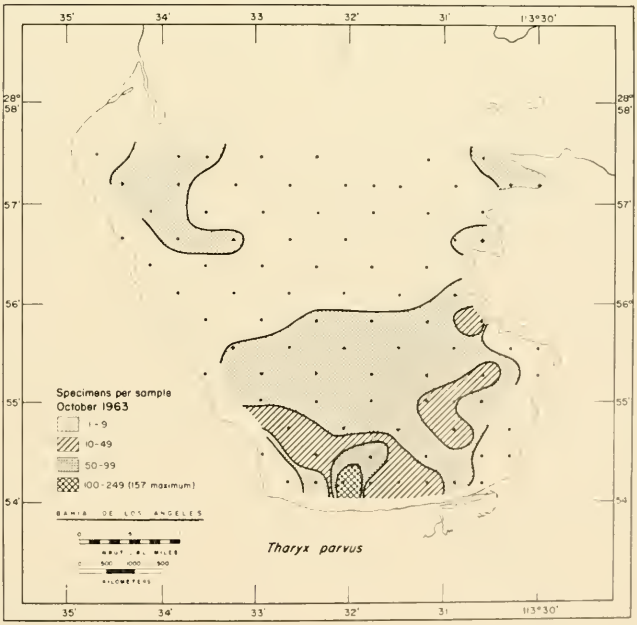

Figure 13. — Benthic distribution of *Tharyx parvus* in October 1963.

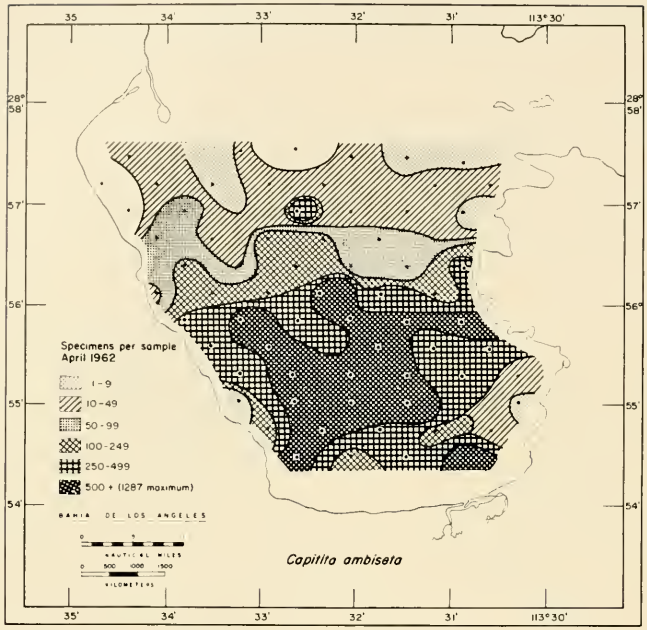

Figure 14. — Benthic distribution of *Capitita ambiseta* in April 1962.

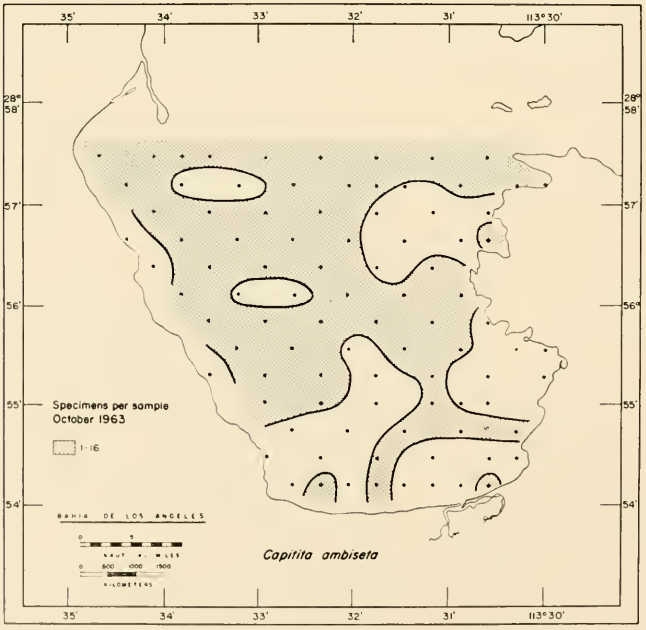

Figure 15. — Benthic distribution of *Capitita ambiseta* in October 1963.

Piromis gracilis Hartman

Piromis gracilis. Hartman, 1961: 123-124.
Material. — April 1962: 3 (3).
Ecology. — Sand and sandy silts.
Distribution. — Oaxaca, Mexico, Guatemala, and Ecuador; the distribution is extended into the Gulf of California.

Family Opheliidae

Armandia bioculata Hartman

Armandia bioculata. Hartman, 1938: 105; Reish, 1963a: 428.
Material. — April 1962: 31 (65); October 1963: 15 (264).
Ecology. — Preference for sandy substrates (Table 2).
Distribution. — California and San Quintin Bay; the distribution is extended into the Gulf of California.

Polyophthalmus pictus (Dujardin)

Nais picta. Dujardin, 1839: 293; *Polyophthalmus pictus*. Imajima and Hartman, 1964: 309.
Material. — April 1962: 1 (81); October 1963: 2 (2).
Ecology. — Found on sands or silty sands.
Distribution. — Cosmopolitan; Rioja (1947) reported it from the lower part of Gulf of California.

Travisia gigas Hartman

Travisia gigas. Hartman, 1938: 103-105; 1961: 34.
Material. — April 1962: 4 (14); October 1963: 1 (3).
Ecology. — Sandy at all stations.
Distribution. — Central and southern California and Cabo San Lucas; the distribution within the Gulf of California is extended northward.

Family Capitellidae

Anotomastus gordiodes (Moore)

Eunotomastus gordiodes. Moore, 1909a: 278-279; *Anotomastus gordiodes*. Hartman, 1947a: 442-444.
Material. — April 1962: 9 (34); October 1963: 3 (3).
Ecology. — Sand or a sand and silt mixture.
Distribution. — California; the distribution is extended into the Gulf of California.

Family Capitellidae

Capitella capitata (Fabricus)

Lumbricus capitatus. Fabricus, 1780: 279; *Capitella capitata*. Fauvel, 1927: 154-155; Reish, 1963a: 428.
Material. — October 1963: 1 (2).
Ecology. — Silty sands.
Distribution. — Cosmopolitan; this is the first report from the Gulf of California.

Capitita ambiseta Hartman

Capitita ambiseta. Hartman, 1947a: 409-410; Reish, 1963: 429.
Material. — April 1962: 67 (18377); October 1963: 54 (215).
Ecology. — *C. ambiseta* was the most abundant species collected; 18,552 specimens were taken. The population was nearly eliminated following the warmer months with only 215 specimens collected from 54 stations in October 1962 (Figs. 14, 15). This species was taken more frequently, but in fewer number, from stations composed of silty sediments. An average of 147, 255, and 182 specimens per station were taken from sandy, silty sand, and sandy silt sediments respectively. The population of *C. ambiseta* in April 1962 was more extensive than that encountered at San Quintin Bay (Reish, 1963a).
Distribution. — Central California south to San Quintin Bay, Baja California; this is the first report from the Gulf of California.

Notomastus (*Clistomastus*) *tenuis* Moore

Notomastus tenuis. Moore 1909a: 277-278; *Notomastus* (*Clistomastus*) *tennuis*, Hartman, 1947a: 420-422; Reish, 1959a, p. 92.
Material. — April 1962: 8 (16); October 1963: 6 (8).
Ecology. — Sands or silty sands.
Distribution. — British Columbia to southern California; this is the first report from the Gulf of California.

Family Arenicolidae

Arenicola sp.

Material. — April 1962: 1 (1).
Remarks. — One specimen lacking the posterior end was taken; it was impossible to make a specific identification. The substrate was sandy at this station.

Family Maldanidae

Asychis disparidentata (Moore)

Maldane disparidentata. Moore, 1904: 494-496; *Asychis disparidentata*. Berkeley and Berkeley, 1952: 46-47.
Material. — April 1962: 1 (1).
Ecology. — Silt.
Distribution. — Known previously from British Columbia, California, and India; this is the first report of the species from the Gulf of California.

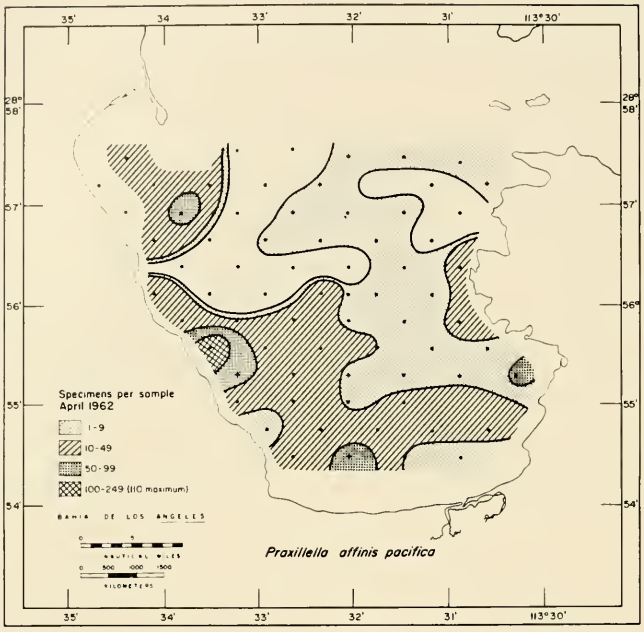

Figure 16. — Benthic distribution of *Praxillella affinis pacifica* in April 1962.

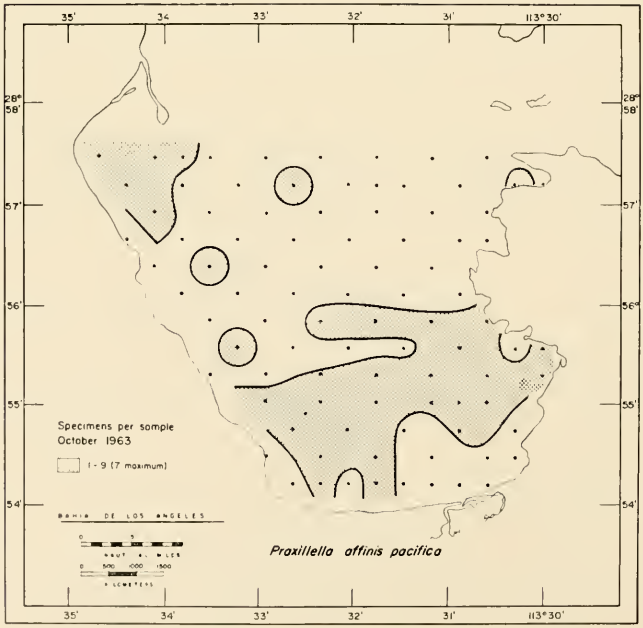

Figure 17. — Benthic distribution of *Praxillella affinis pacifica* in October 1963.

Axiothella rubrocincta (Johnson)

Clymenella rubrocincta. Johnson, 1901: 418-419; *Axiothella rubrocincta*. Berkeley and Berkeley, 1952: 51; Reish, 1963a: 429.
Material. — October 1963: 1 (4).
Ecology. — Silty sands.
Distribution. — British Columbia to San Quintin Bay; the distribution is extended into the Gulf of California.

Heteroclymene glabra Moore

Heteroclymene glabra. Moore, 1923: 229-230; Hartman, 1961: 37.
Material. — April 1962: 37 (382); October 1963: 1 (1).
Ecology. — Equally widespread on all types of sediments, but commonest on sandy substrates (Table 2).
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Maldane sarsi Malmgren

Maldane sarsi. Malmgren, 1865: 188; Fauvel, 1927: 197-199; Hartman, 1961: 37.
Material. — April 1962: 6 (28); October 1963: 5 (7).
Ecology. — Most specimens from sandy silt or a silty benthos.
Distribution. — Cosmopolitan; this is the first report from the Gulf of California.

Praxillella affinis pacifica Berkeley

Praxillella affinis (Sars) var. *pacifica*. Berkeley, 1929: 313-314; Berkeley and Berkeley, 1952: 49-50; *Praxillella affinis pacifica*. Hartman, 1961: 37; Reish, 1959a: 93.
Material. — April 1962: 54 (1040); October 1963: 32 (56).
Ecology. — Occurred mainly on sand and silty sand bottoms. In October the population was nearly eliminated in the outer part of the bay and was much reduced in the inner bay area. (Figs. 16, 17).
Distribution. — British Columbia to southern California; the distribution is extended into the Gulf of California.

Family Oweniidae

Owenia fusiformis collaris Hartman

Owenia fusiformis collaris. Hartman, 1955: 46; Reish, 1959a: 94.
Material. — April 1962: 2 (3); October 1963: 6 (8).
Ecology. — Sands.
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Family Pectinariidae

Pectinaria (*Pectinaria*) **hartmanae**, new species

Figure 18 a-e

Material. — April 1962: 6 (6).

Diagnosis. — Length 15-20 mm, width at anterior end 3-4 mm; cephalic spines brassy, number from 8 to 10 pairs, long, flattened, recurved, antennuated tips (Fig. 18a); antennular membrane with about 30 filiform fringes; about 30 varying sized oral tentacles; two pairs pectinate branchiae the anterior longer than the posterior; setigerous segments 1 to 3 with only notopodial fascicle; the next 12 segments with both components; notosetae of two types, both tapered to a point, one nearly smooth (Fig. 18b), the other limbate, denticulated and incised (Fig. 18c); uncini in neuropodium wih 7 major teeth in two rows and many smaller teeth medially (Fig. 18d); scaphal hooks (Fig. 18e) number from 8 to 10, blunt, brassy in color; anal tongue with median papillae and crenulated margin; tube, straight, length 25 mm; consists of coarse silicious grains.

Remarks. — The subgenus *Pectinaria* was previously known from 18 species (Hartman, 1959b). These species can be grouped conveniently according to the number of segments with notosetae. Further groupings may be made on the number of segments with uncini. *P. hartmanae* and *P. nana* Wesenberg-Lund (1949), from the Gulf of Oman, are the only two species known with 15 pairs of notosetae. Both species have 12 uncinigerous segments. These two species are separated from one another on the basis of 8-10 pairs of cephalic spines in *P. hartmanae* and 11 pairs in *P. nana*, 8-10 pairs of scaphal hooks in the former and 3 pairs in the latter, and antennular membrane with 30 fringes in the former and 8 in the latter.

Ecology. — The substrate consisted of silty sand at three of the stations and sand and sandy silt at the other three.

Type material. — The holotype and three additional specimens have been deposited in the U. S. National Museum.

Type locality. — Bahia de los Angeles, Gulf of California, Baja California. This species is named in honor of Dr. Olga Hartman in recognition of her contributions to the knowledge of polychaetes.

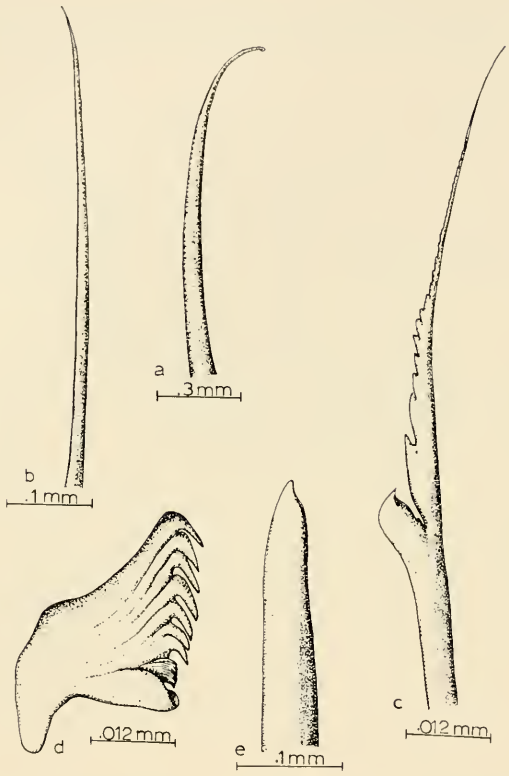

Figure 18. — Pectinaria (*Pectinaria*) hartmanae, n. sp.: a, cephalic spine; b, capillary seta from notopodium; c, limbate seta with incised margin from notopodium; d, uncinus from neuropodium; e, scaphal hook.

Family Ampharetidae

Amphisamytha bioculata (Moore)

Samytha bioculata. Moore, 1906: 253-255; *Amphisamytha bioculata.* Berkeley and Berkeley, 1952: 73.
Material. — April 1962: 6 (38); October 1963: 1 (1).
Ecology. — Preferred silty sands.
Distribution. — British Columbia, southern California, India; this is the first report from the Gulf of California.

Amphicteis scaphobranchiata Moore

Amphicteis scaphobranchiata. Moore, 1906: 255-257; Berkeley and Berkeley, 1952: 68-69.
Material. — April 1962: 7 (23); October 1963: 7 (8).
Ecology. — Preferred silty sands.
Distribution. — British Columbia to southern California; the distribution is extended into the Gulf of California.

Asabellides lineata (Berkeley and Berkeley)

Pseudosabellides lineata. Berkeley and Berkeley, 1943: 131-132; 1952: 71-72; 1956: 241: *Asabellides lineata.* Hartman, 1961: 39.
Material. — April 1962: 1 (1).
Ecology. — Sandy silts.
Distribution. — British Columbia, Alaska, Canadian Arctic, Hudson Bay (Berkeley and Berkeley, 1956) and questionably southern California (Hartman, 1961). The distribution is extended into the Gulf of California.

Family Terebelledae

Amaeana occidentalis (Hartman)

Amaea occidentalis. Hartman, 1944b: 277-278; *Amaeana occidentalis*. Hartman 1959: 495.
Material. — April, 1962: 34 (273); October 1963: 11 (15).
Ecology. — Most frequent on sandy silts but commonest on sands in April 1962.
Distribution. — Central and southern California; the distribution is extended into the Gulf of California.

Pista cristata (Müller)

Amphitrite cristata. Müller, 1776: 40; *Pista cristata*. Fauvel, 1927: 266; Berkeley and Berkeley, 1952: 78-79.
Material. — April 1962: 3 (4); October 1963: 3 (9).
Ecology. — Sand or silty sands.
Distribution. — Cosmopolitan; this is the first report from the Gulf of California.

Polycirris perplexus Moore

Polycirris perplexus. Moore, 1923: 198-199; Hartman, 1961: 41.
Material. — April 1962: 31 (212).
Ecology. — Most specimens from sandy silt or silty substrates.
Distribution. — Southern California; the distribution is extended into the Gulf of California.

Family Trichobranchidae

Terebellides stroemi Sars

Terebellides stroemi. Sars, 1835: 48, Berkeley and Berkeley, 1939: 343; Reish, 1959b: 39; Imajima and Hartman, 1964: 352-353.
Material. — April 1962: 7 (19); October 1963: 3 (3).
Ecology. — All substrates.
Distribution. — Cosmopolitan; Berkeley and Berkeley (1939) reported it from Puerto San Carlos (near Guaymas).

Family Sabellidae

Chone mollis (Bush)

Metachone mollis. Bush, 1904: 216; *Chone mollis*, Hartman, 1944b: 279-280; Reish, 1963a: 430.
Material. — April 1962: 55 (553); October 1963: 14 (34).
Ecology. — Prefers coarser sediments (Table 2).
Distribution. — California and San Quintin Bay; the distribution is extended into the Gulf of California.

Euchone barnardi, new species

Figure 19 a-d

Material. — April 1962: 35 (663); October 1963: 2 (2).
Diagnosis. — Maximum length of 2.0mm including branchial length of 0.5mm; 8 thoracic and 9 abdominal setigerous segments, the last 3 comprise the anal depression; branchiae with 3 radioles per side, with numerous filaments which extend within 0.1mm of the tip, united for one-half of their length; collar little developed dorsally but produced into 2 lobes ventrally; thoracic notopodium with 2-3 superior double-winged capillary setae (Fig. 19a) and 3-4 inferior subspatulate setae (Fig. 19b); 3-4 long handled uncini in thoracic neuropodium, each with a large tooth and 4-5 smaller teeth (Fig. 19c); abdominal notopodium with 5-6 avicular hooks, each with larger tooth and 15-20 teeth (Fig. 19d); abdominal neuropodium including and depression with 4-5 simple capillary setae.
Remarks: — Hartman (1959b) lists 13 and possibly 14 species in the genus *Euchone* Malmgren. Additional species described include *E. limnicola* Reish (1960), *E. incolor* Hartman (1965a), and *E. trisegmentata* Reish (1965). *Euchone barnardi* comes closest to *E. trisegmentata*, *E. rosea* Langerhans, and *E. incolor*. All are small and the three former have only 17 setigerous segments; *E. incolor* possesses from 16-19 setigerous segments. The anal depression consists of 4 segments in *E. rosea;* it consists of 3 segments in *E. barnardi*, *E. trisegmentata* and *E. incolor*. The margins of the anal depression are flared in *E. incolor* but not in *E. barnardi* or *E. trisegmentata*. *Euchone barnardi* and *E. trisegmentata* have 3 pairs of radioles; *E. incolor* has 3 to 4 pairs of radioles. These species all have similar setae but differ in details: superior thoracic notopodial setae double-winged in *E. barnardi* and *E. incolor*, single in *E. trisegmentata;* thoracic neuropodia long-handled hooks with 5-6 teeth in *E. barnardi*, 4-5 in *E. incolor*, and 7 in *E. trisegmentata*, abdominal avicular hooks with 6 rows of teeth in *E. barnardi*, 7 in *E. incolor*, and 10 in *E. trisegmentata*.
Ecology. — All but three of specimens were taken in the April 1962 survey. This species did not exhibit any preference for a particular substrate type.
Type material. — The holotype and paratypes have been deposited in the U. S. National Museum.
Type locality. — Bahia de los Angeles, Gulf of California, Baja California.
This species is named in honor of Dr. J. Laurens Barnard, in appreciation for making these collections available for study.

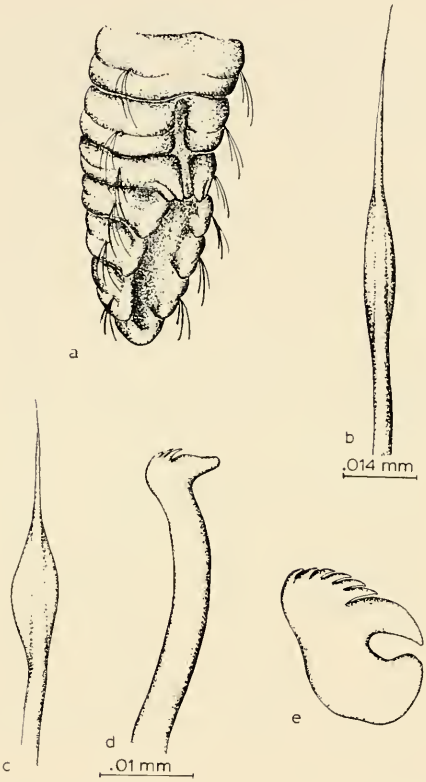

Figure 19. — Euchone barnardi, n. sp.: a, double winged capillary seta from superior thoracic notopodium; b, subspatulate seta from inferior thoracic notopodium; c, long handle uncinus from thoracic neuropodium, magnification as figure b; d, avicular hook from abdominal notopodium.

Euchone cortezi, new species

Figure 20 a-e

Material. — April 1962: 2 (2). Both stations located near Isla Ventana in Bahia de los Angeles.

Diagnosis. — Length 2 to 6mm including the branchial length of 0.5 to 1.5mm; 8 thoracic and 12 to 13 abdominal setigerous segments, the last 5 in two and last 6 in one specimen comprise the anal depression (Fig. 20a); branchiae with 7 radioles per side, united with a membrane for one-half of their length, and the filaments extending to near the tip of the radiole; collar well developed and divided into two lobes with incised margins along the mid-dorsal and mid-ventral line; thoracic notopodium with superior doubled-winged capillary setae (Fig. 20b) and inferior spatulate setae (Fig. 20c); thoracic neuropodium with long handled uncini (Fig. 20d) each with a large tooth and 3 smaller teeth; abdominal notopodium (Fig. 20e), provided with avicular hooks each with a large tooth and 25 to 30 smaller teeth in 6 rows; abdominal neuropodium including the anal depression with simple capillary setae.

Remarks. — Of the 16 to 17 known species in the genus *Euchone* (see under *E. barnardi* above), *E. cortezi* comes closest to *E. papillosa* (Sars) (Malmgren, 1865) on the basis of the number of segments in the anal depression. *Euchone cortezi* has 5 to 6 segments in the region and *E. papillosa* has approximately 6; however, the two species can be readily separated on the basis of the number of segments; there are 20 to 21 in the former and 33 to 34 in the latter. The inferior spatulate setae also differ.

The specific name refers to the Sea of Cortez, a name used for the Gulf of California in the past.

Type material. — The holotype and one paratype have been deposited in the U. S. National Museum.

Type locality. — Near Isla Ventana in Bahia de los Angeles, Gulf of California.

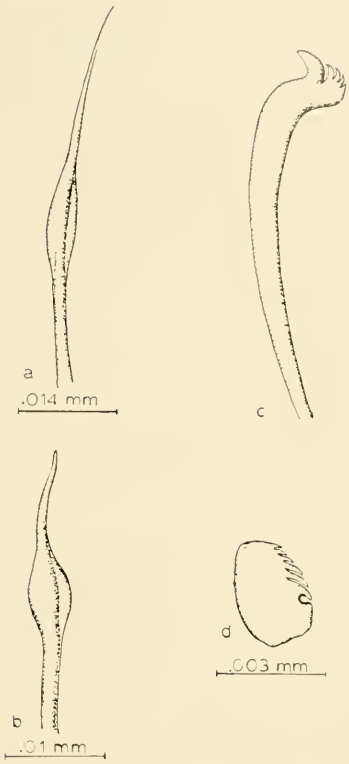

Figure 20. — Euchone cortezi, n. sp.: a, posterior end showing anal depression; b, double winged capillary seta from superior thoracic notopodium; c, subspatulate seta from inferior thoracic notopodium, magnification as figure b; d, long handle uncinus from thoracic neuropodium; e, avicular hook from abdominal notopodium, magnification as figure d.

Fabricia limnicola Hartman

Fabricia limnicola. Hartman, 1951b: 384-385; Reish, 1963a: 430.
Material. — October 1963: 2 (44).
Ecology. — Silty sands and sands.
Distribution. — Southern California and San Quintin Bay; the distribution is extended into the Gulf of California.

Megalomma pigmentum Reish

Megalomma pigmentum. Reish, 1963a: 430-433.
Material. — April 1962: 22 (68); October 1963: 13 (23).
Ecology. — This species showed a preference for sands and silty sands (Table 2); at San Quintin Bay *M. pigmentum* was more commonly taken from finer sediments (Reish, 1963a).
Distribution. — Southern California and San Quintin Bay; the distribution is extended into the Gulf of California.

Family Serpulidae

Hydroides recurvispina Rioja

Hydroides recurvispina. Rioja, 1941: 169-172.
Material. — April 1962: 3 (5); October 1963: 1 (1).
Ecology. — Majority from sands.
Distribution. — Mazatlan and Acapulco; the distribution is extended northward into the Gulf of California.

Literature Cited

Alikunhi, K. H
1943. On an undescribed hermaphrodite species of *Microphthalmus* (Hesionidae) occurring on the sandy beach at Madras. Indian Sci. Congr., Proc. 29: 149-150.

Baird, W.
1863. Descriptions of several new species of worms belonging to the Annelida Errantia and Sedentaria or Tubicola of Milne Edwards. Zool. Soc. London, Proc. 1863, p. 106-110.

Barnard, J. L., and W. E. Grady
1968. A biological survey of Bahía de los Ángeles, Gulf of California, Mexico. I. General Account. San Diego Soc. Nat. Hist., Trans. 15 (6): 51-66.

Berkeley, E.
1929. Polychaetous annelids from the Nanaimo district. 4. Chaetopteridae to Maldanidae. Contr. Can. Biol. Fish., new ser., 4: 305-316.

Berkeley, E., and C. Berkeley
1936. Notes on Polychaeta from the coast of western Canada. I. Spionidae. Ann. Mag. Natur. Hist., ser. 10, 18: 468-477.
1938. Notes on Polychaeta from the coast of western Canada. II. Syllidae. Ann. Mag. Natur. Hist., ser. 11, 1: 33-49.
1939. On a collection of Polychaeta, chiefly from the west coast of Mexico. Ann. Mag. Natur. Hist., ser. 11, 3: 321-346.
1941. On a collection of Polychaeta from Southern California. So. Calif. Acad. Sci., Bull. 40: 16-60.
1943. Biological and oceanographical conditions in Hudson Bay. 11. Polychaeta from Hudson Bay. J. Fish. Res. Bd. Can. 6: 129-132.
1952. Annelida, Polychaeta sedentaria. *In* Canadian Pacific Fauna. J. Fish. Res. Bd. Can. no. 9b: 1-139.

Busch, W.
1851. Beobachtungen über Anatomie und Entwicklung einiger wirbellosen Seethiere. Berlin, A. Hirschwald. 143 p.

Bush, K. J.
1904. Tubicolous annelids of the tribes Sabellides and Serpulides from the Pacific Ocean. Harriman Alaska Exped., N. Y., 12: 169-355.

Chamberlin, R. V.
1919a. The Annelida Polychaeta. Mem. Mus. Comp. Zool. Harvard, 48: 1-514.
1919b. New polychaetous annelids from Laguna Beach, California. J. Entomol. Zool. Pomona, 11: 1-23.

Chiaje, S. delle
1828. Memorie sulla storie e notomia degli animali senza vertebre del Regno di Napoli, 3: 1-232.

Claparede, E.
1863. Beobachtungen über Anatomie und Entwicklungsgeschichte wirbelloser thiere an der Küste von Normandie angestellt. p. 1-120.
1868. Les annélides, chétopodes du Golfe de Naples. Mém. Soc. Phys. Genève, 19: 313-584.
1870. Les annélides chétopodes du Golfe de Naples. Supplément, Mém. Soc. Phys. Genève, 20: 365-452.

Day, J. H.
1954. The Polychaeta of Tristan da Cunha. *In* Results of the Norwegian Scientific Expedition to Tristan da Cunha 1937-1938.

Dujardin, F.
1839. Observations sur quelques annelides marins. Ann. Sci. Natur. Paris, sec 2, 11: 281-294.

Ehlers, E.
1868. Die Bostenwurmer (Annelida Chaetopoda) nach systematischen und anatomischen Untersuchungen dargestellt. Leipzig, Wilhelm Englemann. Vol. 2, p. 269-748.
1901. Die Polychaeten des magellanischen und chilenischen Strandes. Ein faunistischer Versuch. Festschrift zur Feier des Hundertfünfzigjährigen Bestehous der königlichen Gesellschaft der wissenschaften zu Göttingen. (Abl. Math.-Phys.). Berlin, Wiedmannsche Buchlandlung. 232 p.

Fabricius, O.
1780. Fauna groenlandica . . . . 452 p.

Fauvel, P.
1927. Polychètes sédentaires. Faune de France, 16: 1-494.
1943. Annélides polychètes de California recueillies par L. Diguet. Mém. Mus. Hist. Natur. Paris, n. s. 18: 1-32.
1953. Annelida Polychaeta. The Fauna of India including Pakistan, Ceylon, Burma and Malaya. 507 p.

Gravier, C.
1905. Sur un Polynoidien (*Lepidasthenia digueti* nov. sp.) commensal d'un Balanoglosse de Basse-Californie. Bull. Mus. Natur. Paris, 11: 177-181.

GRUBE, A.-E.
1840. Actinien, Echinodermen und Würmen des Adratischen und Mittelmeers. . . ., p. 61-81.
1857. Annulata Oerstediana, pt. 2, p. 158-166.
1863. Beschrieburg neuer oder wenig bekannter Anneliden, Sechster Beitrag. Arch. Naturg. 29: 37-69.

HARTMAN, O.
1936. A review of the Phyllodocidae (Annelida polychaeta) of the coast of California, with descriptions of nine new species. Univ. Calif. Publ. Zool. 41: 117-132.
1938. Descriptions of new species and new generic records of polychaetous annelids from California of the families Glyceridae, Eunicidae, Stauronereidae and Opheliidae. Univ. Calif. Publ. Zool. 43: 93-111.
1939a. Polychaetous annelids, Pt. I. Aphroditidae to Pisionidae. Allan Hancock Pacific Exped. 7: 1-156.
1939b. New species of polychaetous annelids from southern California. Allan Hancock Pacific Exped. 7: 157-172.
1940. Polychaetous annelids, Pt. II. Chrysopetalidae to Goniadidae. Allan Hancock Pacific Exped. 7: 173-287.
1941. Some contributions to the biology and life history of Spionidae from California. Allan Hancock Pacific Exped. 7: 289-324.
1944a. Polychaetous annelids, Pt. V. Eunicea. Allan Hancock Pacific Exped. 10: 1-238.
1944b. Polychaetous annelids from California, including the description of two new genera and nine new species. Allan Hancock Pacific Exped. 10: 239-307.
1944c. Polychaetous annelids, Pt. VI. Paraonidae, Magelonidae, Longosomidae, Ctenodrilidae and Sabellariidae. Allan Hancock Pacific Exped. 10: 311-389.
1947a. Polychaetous annelids, Pt. VII. Capitellidae. Allan Hancock Pacific Exped. 10: 391-481.
1947b. Polychaetous annelids, Pt. VIII. Pilargiidae. Allan Hancock Pacific Exped. 10: 482-523.
1948. The marine annelids erected by Kinberg with notes on some other types in the Swedish State Museum. Ark. Zool. Svenska Vetensk. 42A: 1-137.
1950. Goniadidae, Glyceridae and Nephtyidae. Allan Hancock Pacific Exped. 15: 1-180.
1951a. The littoral marine annelids of the Gulf of Mexico. Publ. Inst. Marine Sci. 2: 7-124.
1951b. Fabricinae (feather-duster polychaetous annelids) in the Pacific. Pacific Sci. 5: 379-389.
1954. Australian Nereidae, including descriptions of three new species and one new genus, together with summaries of previous records and keys to species. Trans. Roy. Soc. So. Austr. 77: 1-41.
1955. Endemism in the North Pacific Ocean, with emphasis on the distribution of marine annelids, and descriptions of new or little known species, p. 39-60. *In* Essays in the Natural Sciences in honor of Captain Allan Hancock, Los Angeles, Calif.
1957. Orbiniidae, Apistobranchidae, Paraonidae and Longosomidae. Allan Hancock Pacific Exped. 15: 211-392.
1959. Catalogue of the polychaetous annelids of the world, parts 1-2. Allan Hancock Foundation Publ. Occ. Pap. 23.
1960. Systematic account of some marine invertebrate animals from the deep basins off southern California. Allan Hancock Pacific Exped. 22: 69-214.
1961. Polychaetous annelids from California. Allan Hancock Pacific Exped. 25: 1-226.
1963. Submarine canyons of southern California, Pt. III. Systematics: Polychaetes. Allan Hancock Pacific Exped. 27: 1-93.
1965a. Deep-water benthic polychaetous annelids off New England to Bermuda and other North Atlantic areas. Allan Hancock Foundation Publ. Occ. Pap. 28.
1965b. Supplement and index to the catalogue of the polychaetous annelids of the world, including additions and emendations since 1959. Allan Hancock Foundation Publ. Occ. Pap. 23.

HARTMANN-SCHRÖDER, G.
1962a. Zweiter Beitrag zur Polychaeten fauna von Peru. Kieler Meeresforsch. 18: 109-147.
1962b. Zur Kenntnis des Eulitorals der chilenischen Pazifikküste und der argentinischen Kuste Sudpatagoniens unter Ostracoden. Teil II. Die Polychaeten des Eulitorals. Mitt. Hamb. Zool. Mus. Inst. 60: 57-167.

IMAJIMA, M., and O. HARTMAN
1964. The polychaetous annelids of Japan. Allan Hancock Foundation Publ. Occ. Pap. 26.

JOHNSON, H. P.
1897. A preliminary account of the marine annelids of the Pacific coast with descriptions of new species. Calif. Acad. Sci. Proc., Zool. ser. 3, 1: 153-198.
1901. The polychaeta of the Puget Sound region. Boston Soc. Natur. Hist. Proc., 29: 381-437.

KINBERG, J. H.
1866. Annulata nova. Förh. Ofv. vet. Akad. Stockholm, 22: 167-179.

LAUBIER, L.
1962. Quelques annélides polychètes de la lagune de Venise, description de *Prionospio caspersi* n. sp. Vie et Milieu, 13:123-159.

Leidy, J
1855. Contributions toward a knowledge of the marine invertebrates of the coasts of Rhode Island and New Jersey. J. Acad. Natur. Sci. Phila. 3: 135-158.

Malmgren, A. J.
1865. Nordiska Hafs-Annulater. Förh Ofv. Kongl. vet. Akad. Stockholm, 1: 51-110; 2: 181-192; 5: 355-410.

Mecznikow, E.
1865. Beiträge zur Kenntnis der Chaetopoden. Zeitschr. Wiss. Zool., 15: 328-341.

Monro, C. C. A.
1928. On the polychaeta collected by Dr. H. Montensen off the coast of Panama. Vidensk. Medd. Natur. Foren. Kjöbenhavn. 85: 75-103.

Moore, J. P.
1904. New polychaetes from California. Acad. Natur. Sci. Phila., Proc. 56: 484-503.
1906. Additional new species of polychaeta from the north Pacific. Acad. Natur. Sci. Phila., Proc. 58: 217-260.
1907. Descriptions of new species of spioniform annelids. Acad. Natur. Sci. Phila., Proc. 59: 195-207.
1908. Some polychaetous annelids of the northern Pacific coast of North America. Acad. Natur. Sci. Phila., Proc. 60: 321-364.
1909a. Polychaetous annelids from Monterey Bay and San Diego. Acad. Natur. Sci. Phila., Proc. 61: 225-295.
1909b. The polychaetous annelids by the U. S. S. *Albatross* off the coast of southern California in 1904. I. Syllidae, Sphaerodoridae, Hesionidae and Phyllodocidae. Acad. Natur. Sci. Phila., Proc. 61: 321-351.
1910. The polychaetous annelids dredged by the U. S. S. *Albatross* off the coast of southern California in 1904. II. Polynoidae, Aphroditidae and Segalionidae. Acad. Natur. Sci. Phila., Proc. 62: 328-402.
1911. The polychaetous annelids dredged by the U. S. S. *Albatross* off the coast of southern California in 1904. Euphrosynidae to Goniadidae. Acad. Natur. Sci. Phila., Proc. 63: 234-318.
1923. The polychaetous annelids dredged by the U. S. S. *Albatross* off the coast of southern California in 1904. Spionidae to Sabellariidae. Acad. Natur. Sci. Phila., Proc. 75: 179-259.

Müller, O. F.
1776. Zoologiae Danicae prodromus, seu animalium Daniae et Norvegiae . . . . 274 p.

Oersted, A. S.
1843. Groenlands Annulata dorsibranchiata. K. Danske Videns. Selsk. Natur. Math. 10: 155-216.

Parker, R. H.
1963. Zoogeography and ecology of some macroinvertebrates, particularly mollusks, in the Gulf of California and the continental slope off Mexico. Vidensk. Medd. fra Dansk natur. Foren. 126: 1-178.

Pettibone, M. H.
1954. Marine polychaete worms from Point Barrow, Alaska, with additional records from the North Atlantic and North Pacific. U. S. Nat. Mus., Proc. 103: 213-356.
1963. Marine polychaeta worms of the New England region. I. Aphroditidae through Trochochaetidae. U. S. Nat. Mus., Bull. 227.

Potts, F. A.
1910. Polychaeta of the Indian Ocean. Pt. II. The Palmyridae, Aphroditidae, Polynoidae, Acoetidae and Sigalionidae. Trans. Linn. Soc. Zool., sec. 2, 16: 325-353.

Reish, D. J.
1959a. Benthic polychaetous annelids. Pt. III. Allan Hancock Foundation Publ. Occ. Pap. 21, p. 70-106.
1959b. An ecological study of pollution in Los Angeles-Long Beach Harbors, California. Allan Hancock Foundation Publ. Occ. Pap. 22.
1959c. New species of Spionidae (Annelida, Polychaeta) from southern California. So. Calif. Acad. Sci., Bull. 58: 11-16.
1960. A new species of Sabellidae (Annelida, Polychaeta) from southern California. Ann. Mag. Natur. Hist. London, ser. 13, 2: 717-719.
1963a. A quantitative study of the benyhic polychaetous annelids of Bahía de San Quintín, Baja California. Pacific Natur. 3: 399-436.
1963b. Mass mortality of marine organisms attributed to the "red tide" in southern California. Calif. Fish and Game, 49: 265-270.
1965. Benthic polychaetous annelids from Bering, Chukchi, and Beaufort Seas. U. S. Nat. Mus., Proc. 117: 131-158.

Reish, D. J., and J. L. Barnard
1967. The benthic polychaeta and amphipoda of Morro Bay, California. U. S. Nat. Mus., Proc. 120: 1-26.

RIOJA, E.
1939. Estudios anelidológicos I. Observaciones acerca de varias formas larvarias y postlarvarias pelagicas de Spionidae, precedentes de Acapulco, con descripcion de una especie neuva del genero *Polydora*. Ann. Inst. Biol. México. 10: 297-311.
1941. Estudios anelidológicos III. Datus par el conocimiento de la fauna de poliquetos de las costas del Pacífico de Mexico. Ann. Inst. Biol. Mexico. 12: 669-746.
1943. Estudios anelicologicos VI. Aportaciones al conocimiento de los Exogoninos (Anélides poliquetos) de las costas del Pacífico. Ann. Inst. Biol. México. 14: 207-227.
1944. Estudios anelidológicos XI. Notas sobre algunas especies de poliquetos de la costas Mexicanas del Pacifico. Ann. Inst. Biol. México. 15: 139-145.
1947a. Estudios anelidológicos XVII. Contribucion as concocimiento de los anélidos poliquetos de Baja California y mar de Cortés. Ann. Inst. Biol. México. 18: 197-224.
1947b. Estudios anelidológicos XVIII. Observaciones y datos sobre algunos anélidos poliquetos de Golfo de California y costas de Baja California. Ann. Inst. Biol. México. 18: 517-526.
1959. Estudios anelidológicos XXIII. Contribucion al conocimiento de las Islas de Revillagigeda. Ann. Inst. Biol. México. 30: 243-259.

SARS, M.
1835. Beskrivelsev og iagttagelser over nogle mockelige eller nye i havet ved den Bergeske kyst levende dyr. . . . 81 p.
1851. Beretning om en i sommeren 1849 fortagen zoologisk reise i loften og fin marken. Nyt. Mag. Naturv. 6: 121-211.

SCHMARDA, L. K.
1861. Neue wirbellose thiere beobachtet und gesammelt aug in einer Reise um die Erde 1853 bis 1857. Leipzig, vol. 1, Turbellarien, Rotatorien und Anneliden, pt. 2, p. 1-164.

SOUTHERN, R.
1914. Archiannelida and Polychaeta. *In* Clare Island survey, pt. 47. Roy. Irish Acad. Dublin, Proc. 31: 1-160.

STEINBECK, J., and E. F. RICKETTS
1941. Sea of Cortez. A leisurely journal of travel and research. With a scientific appendix . . . . Viking Press, New York. 598 p.

TEBBLE, N.
1960. The distribution of pelagic polychaetes in the South Atlantic. Discovery Repts. 30: 161-300.

TREADWELL, A. L.
1901. The polychaetous annelids of Porto Rico. U. S. Fish Comm. Bull. 20: 183-210.
1914. Polychaetous annelids of the Pacific coast in the collection of the zoological museum of the University of California. Univ. Calif. Publ. Zool. 13: 175-234.
1923. Polychaetous annelids from Lower California with descriptions of new species. Amer. Mus. Novitates, 74.
1929. New species of polychaetous annelids in the collections of the American Museum of Natural History, from Porto Rico, Florida, Lower California, and British Somaliland. Amer. Mus. Novitates, 392.
1937. The Templeton Crocker Expedition. VIII. Polychaetous annelids from the west coast of Lower California, the Gulf of California and Clarion Island. Zoologica, 22: 139-160.
1942. Polychaetous annelids from Lower California and the Philippine Islands in the collection of the American Museum of Natural History. Amer. Mus. Novitates. 1172.

USCHAKOV, P. V.
1955. [Polychaetes from the seas in the far East.] Akademia Nauk SSSR. Opredeliteli po Faune USSR, no. 56, 445 p. [in Russian].

WESENBERG-LUND, E.
1949. Polychaetes of the Iranian Gulf. Danish Sci. Invest. Iran, pt. 4, p. 247-400.

WIREN, A.
1883. Chaetopoder from Sibiriska Ishafvet och Berings Haf insamlade uner *Vega*-Expeditionen 1878-79. Vega-Exped.-Vetenskapliga Iakttagelser, 2: 383-428.

WOODWICK, K. H.
1961. *Polydora rickettsi*, a new species of spionid polychaete from Lower California. Pacific Sci., 15: 78-81.
1964. *Polydora* and related genera (Annelida Polychaeta) from Eniwetok, Majuro, and Bikini Atolls, Marshall Islands. Pacific Sci., 18: 146-159.

ZACHS, I.
1925. Nouvelles additions a la faune des Polychaeta du Nauman. Acad. Sci. Russ. Leningrad, C. R., sec. A, p. 1-3.

ACCEPTED FOR PUBLICATION 27 FEBRUARY 1968

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Appendix

Table 1

Polychaetes reported from the Gulf of California. An asterisk denotes new distributional records for the area. The names listed are those accepted by the author cited.

Aphroditidae

Aphrodita japonica Marenzeller. Hartman, 1939a. Isla Partida; Isla Espiritu Santo.
A. parva Moore. Hartman, 1939a. Bahia de San Ignacio; Sinaloa.
Pontogenia laeviseta Hartman, 1939a. Isla Angel de la Guarda.

Polynoidae

Arctonoe vittata (Grube). Treadwell, 1923. La Paz.
Chaetocanthus magnificus (Grube). Treadwell, 1937; Berkeley and Berkeley, 1939; Hartman, 1959. Isla Espiritu Santo; Banco Arena.
Halosydna brevisetosa Kinberg. Fauvel, 1943. Gulf.
H. fuscomarmorata (Grube). Fauvel, 1943. Gulf.
H. glabra Hartman, 1939a; Fauvel, 1943; Steinbeck and Ricketts, 1941. Bahia de la Concepcion, Cabo Pulmo, Gulf.
H. johnsoni (Darboux). Berkeley and Berkeley, 1939. Georges Is.; Punta Penasco, Sonora; San Felipe.
H. latior Chamberlin. Rioja, 1947a. Topolobampo; Bahia de Navachiste.
Harmothoe hirsuta Johnson. Rioja, 1947a. Topolobampo.
Hololepida veleronis Hartman, 1939a. Bahia de San Francisquito; Isla Angel de la Guarda.
Iphione muricata (Savigny). Fauvel, 1943. Gulf.
I. ovata Kinberg. Hartman, 1939a; Steinbeck and Ricketts, 1941, west side of Gulf between 24° and 26° W. Latitude.
Lepidametria gigas (Johnson). Berkeley and Berkeley, 1939. San Felipe.
Lepidasthenia digueti Gravier, 1905; Fauvel, 1943. La Paz and Gulf.
L. ornata Chamberlin. Treadwell, 1937. Banco Arena.
Lepidonotus caelorus Moore. Treadwell, 1937; Rioja, 1947a. Banco Arena and La Paz.
L. clava (Montagu). Fauvel, 1943. La Paz.
L. hupferi Augener. Hartman, 1939a; Steinbeck and Ricketts, 1941; Rioja, 1947a. Estero de Agiabampo; Bahia de la Concepcion; La Paz.
L. purpureus Potts. Berkeley and Berkeley, 1939; Hartman, 1959. Isla Angel de la Guarda.
L. versicolor Ehlers. Hartman, 1939a; Rioja, 1947a. Bahia de San Francisquito; Isla San Esteban; Topolobampo.
Thormora johnstoni (Kinberg). Hartman, 1939a; Steinbeck and Ricketts, 1941; Rioja, 1947a. Baja Calif. side of Gulf between 24° and 29° W. Lattiude.

Polyodontidae

Panthalis adumbrata Hoagland. Treadwell, 1937. Bahia de Santa Inez.
**P. pacifica* Treadwell.
**Polyodontes frons* Hartman.
P. oculea (Treadwell). Hartman, 1939a; Steinbeck and Ricketts, 1941. Pichilinque Harbor, Estero de Agiabampo.

Sigalionidae

Eupholoe philippinensis McIntosh. Berkeley and Berkeley, 1939. Isla Espiritu Santo.
**Sthenolepis fimbriarum* Hartman; 1939a. Isla del Carmen, near Isla Espiritu Santo.
Psammolyce myops Hartman, 1939a. Near Isla Espiritu Santo.
Sthenelais maculata Hartman, 1939a. Isla Espiritu Santo.
S. neoleanirae Hartman, 1939a. Isla del Carmen.
**Stenelanella uniformis* Moore.
Thalenessa lewisii (Berkeley and Berkeley), 1939; Hartman, 1939a; Steinbeck and Ricketts, 1941; Fauvel 1943. Cabo San Lucas, Isla Espiritu Santo, Bahia de los Angeles.

Pareulepidae

**Pareulepis fimbriata* (Treadwell).

Chrysopetalidae

Bhawania riveti (Gravier). Steinbeck and Ricketts, 1941. La Paz.
**Paleanotus bellis* (Johnson). Bahia de los Angeles.
P. chrysolepis Schmarda. Rioja, 1947a. La Paz.
P. purpurea Rioja, 1947b. La Paz.

Amphionomidae

Chloeia conspicua Horst. Rioja, 1943. Gulf.
C. entypa Chamberlin. Treadwell, 1937; Rioja, 1947a. Cabo San Lucas, La Paz, Bahia de Santa Inez, Topolobampo.

C. flava (Pallas). Treadwell, 1923. Bahia de San Francisquito.
C. pinnata Moore. Berkeley and Berkeley, 1939. Isla Espiritu Santo.
(?)*C. rosea* Potts [sic]. Fauvel, 1943. Gulf.
C. viridis Schmarda. Hartman, 1939; Berkeley and Berkeley, 1939; Steinbeck and Ricketts, 1941. Common in Gulf.
Eurythoe complanata (Pallas). Hartman, 1939a; Berkeley and Berkeley, 1939; Steinbeck and Ricketts, 1941; Fauvel, 1943; Rioja, 1947a. Common in Gulf.
(?)*E. dubia* Horst [sic]. Fauvel, 1943. Gulf.
Notopygos hispida Potts. Fauvel, 1943. Gulf.
N. ornata Grube. Hartman, 1939a; Berkeley and Berkeley, 1939; Steinbeck and Ricketts, 1941; Rioja, 1947a. Common in Gulf.
**Pareurythoe californica* (Johnson).

Euphrosinidae
Euphrosine aurantiaca Johnson. Rioja, 1947a. La Pa
E. bicirrata Moore. Hartman, 1939a. Isla Partida.

Phyllodocidae
Anaitides lamellifera (Pallas). Fauvel, 1943. Gulf.
A. madeirensis (Langerhans). Treadwell, 1937; Steinbeck and Ricketts, 1941; Fauvel, 1943. Common in Gulf.
**A. mucosa* (Oersted).
A. panamensis (Treadwell). Fauvel, 1943. La Paz.
**A. williamsi* Hartman.
**Eteone dilatae* Hartman.
Eulalia myriacyclum (Schmarda). Steinbeck and Ricketts, 1941. Puerto Refugio.
Eumida sanguinea (Oersted). Rioja, 1947a. La Paz.
**Paranaitis polynoides* (Moore).
Phyllodoce digueti Fauvel, 1943. Gulf.

Typhloscolecidae
**Typhloscolex mulleri* Busch.

Hesionidae
Hesione genetta Grube. Fauvel, 1943. Gulf.
H. intertexta Grube. Berkeley and Berkeley, 1939; Hartman, 1940; Rioja, 1947a. Common in Gulf.
H. pantherina Risso. Fauvel, 1943. Isla San Jose.
Leocrates chinensis Kinberg. Hartman, 1940. Isla Espiritu Santo.
**Microphthalmus riojai* n. sp.
Ophiodromus pugettensis (Johnson). Steinbeck and Ricketts, 1941; Rioja, 1947a. Cabo Pulmo, Topolobampo.
**Oxydromus brunnea* Hartman.
**O. arenicolus glabrus* Hartman.
**Syllidia liniata* Hartmann-Schröder.

Pilargidae
**Ancistrosyllis bassi* Hartman.
**Loandalia fauveli* Berkeley and Berkeley.
**Pilargis hamatus* Hartman.

Syllidae
Autolytus varius Treadwell. Rioja, 1947a. La Paz, Bahia de Navachiste.
**Brania limbata* (Claparède).
**Exogone lourei* Berkeley and Berkeley.
**Langerhansia heterochaeta* (Moore).
Odontosyllis phosphorea Moore. Rioja, 1947a. La Paz.
**Pionosyllis gigantea* Moore.
**Sphaerosyllis erinaceus* Claparède.
Syllis elongata (Johnson). Rioja, 1947a. La Paz, Topolobampo.
Typosyllis hyalina (Grube). Rioja, 1947a. La Paz.

Nereidae
Ceratonereis mirabilis Kinberg. Treadwell, 1929; Hartman, 1940; Steinbeck and Ricketts, 1941; Fauvel, 1943; Rioja, 1947a. Common in Gulf.
C. paucidentata (Moore). Fauvel, 1943. Gulf, La Paz.
Neanthes succinea (Frey and Leuckart). Rioja, 1947a. Estero de Agiabampo; Topolobampo.
Nereis grubei (Kinberg). Fauvel, 1943. Gulf.
**N. procera* Ehlers.
N. rava Ehlers. Berkeley and Berkeley, 1939. Isla Espiritu Santo.
N. riisei Grube. Hartman, 1940; Fauvel, 1943. Gulf.
N. zonata Malmgren. Hartman, 1940. Isla San Esteban.

Nicon mexicana. (Treadwell). Treadwell, 1942. Topolobampo, Isla San Jose.
N. moniloceras (Hartman). Hartman, 1940. Isla San Esteban.
Platynereis bicanaliculata (Baird). Treadwell, 1914; Hartman, 1940; Steinbeck and Ricketts, 1941. Common in Gulf.
P. polyscalma Chamberlin. Hartman, 1940; Steinbeck and Ricketts, 1941. Between 23° and 27° W. Latitude.
Pseudonereis gallapagensis Kinberg. Fauvel, 1943. Gulf.

Nephtyidae

Aglaophamus dicirris Hartman. Hartman, 1940. Common in Gulf.
A. dibranchis (Grube). Treadwell, 1937; Hartman, 1940. Bahia de San Francisquito, Isla del Carmen. Cabo San Lucas.
A. inermis Ehlers. Hartman, 1940. Isla Espiritu Santo.
Nephtys caecoides Hartman. Hartman, 1940. Isla Partida.
N. magellanica Augener. Hartman, 1940. Common in Gulf.
N. panamensis Monro. Hartman, 1940. Between 24° and 29° W. Latitude.
N. singularis Hartman, 1940. Cabeza Ballona.
N. squamosa Ehlers. Hartman, 1940, 1950. Common in Gulf.

Glyceridae

Glycera americana Leidy. Hartman, 1940. Common in Gulf.
G. capitata Oersted. Hartman, 1950. Arroyo de San Luis.
G. capitata branchiopoda Moore. Chamberlin 1919a. 26° 48′ W. Latitude, 110° 45′ 20″ N. Longitude.
G. dibranchiata Ehlers. Steinbeck and Ricketts 1941; Fauvel 1943. Gulf.
G. mexicana (Chamberlin). Chamberlin, 1919a. 27° 39′ 40″ W. Latitude, 111° 0′ 30″ N. Longitude.
**G. robusta* Ehlers.
G. rugosa Johnson. Treadwell, 1937. Bahia de Santa Ynez.
G. tesselata Grube. Hartman, 1940; Rioja, 1947a. Common in Gulf.

Goniadidae

**Glycinde armigera* Moore.
Goniada acicula Hartman, 1940. Between 24° 22′ W. Latitude and 29° 33′ N. Longitude.
**G. littorea* Hartman.

Onuphidae

Diopatra chiliensis Quatrefages. Fauvel, 1943. Gulf.
D. neapolitana delle Chiaje. Fauvel, 1943. Gulf.
D. neotridens Hartman, 1944a. Isla Angel de la Guarda.
D. obliqua Hartman, 1944a. Between 27° 57′ W. and 31° 19′ W. Latitude.
D. ornata Moore. Berkeley and Berkeley, 1939. Bahia de las Animas.
D. splendissima Kinberg. Rioja, 1947a. La Paz, Topolobampo.
D. tridentata Hartman, 1944a; Rioja 1947b, Gulf.
Hyalinoecia juvenalis Moore. Treadwell, 1937; Hartman, 1944a; Rioja, 1947b. Common in Gulf.
Nothria stigmatis cirrata Hartman, 1944a. Bahía Tepoca.
Onuphis eremita Audouin and Milne Edwards. Rioja, 1947b. Topolobampo.
O. nannognathus Chamberlin, 1919a. 25° 59′ W. Latitude and 108° 40′ N. Longitude.
**O. nebulosa* Moore.
O. vexillaria Moore, 1911. Estado de Sonora.
O. zebra Berkeley and Berkeley, 1939; Rioja, 1947a. La Paz.

Eunicidae

Eunice afra Peters. Steinbeck and Ricketts, 1941; Hartman, 1944a. Isla Espiritu Santo.
E. a. paupera Grube. Fauvel, 1943. Gulf.
E. antennata (Savigny). Berkeley and Berkeley, 1939; Steinbeck and Ricketts, 1941; Fauvel, 1943; Hartman, 1944a. Common in Gulf.
E. aphroditois (Pallas). Steinbeck and Ricketts, 1941; Fauvel, 1943; Hartman, 1944a. Common in Gulf.
E. australis Quatrefages. Fauvel, 1943. La Paz.
(?)*E. coccinea* Grube. [sic]. Fauvel, 1943. Gulf.
E. filamentosa Grube. Steinbeck and Ricketts, 1941; Fauvel, 1943; Hartman, 1944a. Gulf.
E. indica Kinberg. Fauvel, 1943. Isla San Jose.
E. longicirrata Webster. Berkeley and Berkeley, 1939; Hartman, 1944a. Common in Gulf.
E. multipectinata Moore. Fauvel, 1943. Gulf.
E. schemacephala Schmarda. Steinbeck and Ricketts, 1941. Isla Espiritu Santo.
E. tentaculata Quatrefages. Fauvel, 1943. Gulf. [perhaps *E. aphoditois, fide* Hartman, 1959b].
E. vittata (delle Chiaje). Hartman, 1944a; Rioja, 1947a. La Paz to Bahía de los Angeles.
Marphysa aenea (Blanchard). Steinbeck and Ricketts, 1941; Hartman, 1944a. Isla Espiritu Santo, El Mogote.
M. mortenseni Monroe. Berkeley and Berkeley, 1939. Isla Espiritu Santo.

M. sanguinea (Montagu). Hartman, 1944a; Rioja, 1947b. Isla de Jorge. Isla Angel de la Guarda, La Paz.
M. stylobranchiata Moore. Rioja, 1947a. La Paz. Bahia de Navachiste.
**Nematonereis unicornis* (Grube).
Nicidion cariboca (Grube). Hartman, 1944a. Isla Espiritu Santo.
Palola paloloides (Moore). Rioja, 1947a. La Paz, Topolobampo.
P. siciliensis (Grube). Hartman, 1940; Steinbeck and Ricketts, 1941, Fauvel, 1943. Common in Gulf.

Lumbrineridae

Lumbrineris bifilaris (Ehlers). Hartman, 1944a; Rioja, 1947a. La Paz, Los Frailes.
L. branchiata Fauvel, 1943. [Homonym, *fide* Hartman, 1959b, p. 333.]
L. brevicirra (Schmarda). Fauvel, 1943. La Paz, Isla San Jose.
L. erecta (Moore). Hartman, 1944a. Between 24° 25′ and 29° 54′ W. Latitude.
L. inflata Moore. Fauvel, 1943; Hartman, 1944a. Isla Partida.
L. latreilli Audouin and Milne Edwards. Hartman, 1944a. Between 25° 49′ and 31° 01′ W. Latitude.
L. l. japonica Marenzeller. Hartman, 1944a. Bahia de San Francisquito.
**L. minima* Hartman.
L. simplicis Hartman, 1944a, 1959. Isla Angel de la Guarda, Bahia San Luis Gonzaga.
L. tetraura (Schmarda). Hartman, 1944a. Isla Tuburon, Isla Espiritu Santo, Bahia Tepoca.

Arabellidae

Arabella iricolor (Montagu). Hartman, 1944a; Rioja, 1947a. Common in Gulf.
A. mutans (Chamberlin). Fauvel, 1943; Hartman, 1944a. Isla Angel de la Guarda, Bahia Agua Verde.
A. semimaculata (Moore). Hartman, 1944a; Rioja, 1947b. Between 24° and 30° W. Latitude.
Drilonereis filum (Claparède). Fauvel, 1943. Gulf.
D. facata Moore. Hartman, 1944a. Isla Espiritu Santo.
D. nuda Moore. Fauvel, 1943. Gulf.

Lysaretidae

Aglaurides fulgida (Savigny). Steinbeck and Ricketts, 1941; Fauvel, 1943; Hartman, 1944a. Common in Gulf.

Dovilleidae

Dorvillea articulata (Hartman). Rioja 1947a. La Paz.
D. cerasina (Ehlers). Steinbeck and Ricketts, 1941; Hartman, 1944a. Between 24° and 29° W. Latitude.
**Protodorvillea gracilis* (Hartman).

Orbiniidae

**Haploscoloplos elongatus* (Johnson).
Naineris laevigata (Grube). Rioja, 1947b. Topolobampo.
**Orbinia johnsoni* (Moore).
**Phylo felix* Kinberg.
**P. nudus* (Moore).
**Scoloplos acmeceps* Chamberlin.

Paraonidae

**Aricidea rosea*, n. sp.
**A. uschakowi* Zachs.
**Paradoneis lyra* (Southern)
**Paraonis gracilis oculata* Hartman.

Spionidae

Aonides californiensis Rioja, 1947a. La Paz.
**Laonice cirrata* (Sars).
**Nerinidis acuta* (Treadwell).
**N. maculata* Hartman.
**N. pigmentata* (Reish).
Polydora ciliata (Johnston). Rioja, 1943. Guaymas.
P. cirrosa Rioja, 1943. Guaymas.
**P. heterochaeta* Rioja.
P. ligni Webster. Rioja, 1943, 1947a. Guaymas, Topolobampo.
P. rickettsi Woodwick, 1961. Cabo San Lucus.
P. socialis (Schmarda). Rioja, 1947a. La Paz.
**P. s. plena* Berkeley and Berkeley.
**Prionospio cirrifera* Wiren. Bahia de los Angeles.
**P. longibranchiata*, n. sp.
**P. malmgreni* Claparède.
**P. pinnata* Ehlers.
**P. pygmaeus* Hartman.
**Pseudopolydora reishi* Woodwick.

Spiophanes bombyx (Claparède).
*S. *missionensis* Hartman.

Magelonidae
*M. *californica* Hartman.

Disomidae
**Poecilochaetus johnsoni* Hartman.

Chaetopteridae
Chaetopterus variopedatus (Renier). Fauvel, 1943; Rioja 1947b. La Paz.
**Telepsavus costarum* Claparède.

Cirratulidae
**Acrocirrus crassifilis* Moore.
**Caulleriella alata* (Southern).
**Chaetozone corona* Berkeley and Berkeley.
Cirratulus exuberans Chamberlin. Treadwell, 1937. Gulf.
C. sinincolens Chamberlin. 26° 48′ W. Latitude and 110° 45′ 20″ N. Longitude.
Cirriformia luxuriosa (Moore). Rioja, 1947a. Bahia de Navachiste.
C. spirabrancha (Moore). Steinbeck and Ricketts 1941. Bahia de los Angeles, Coronados.
**Cossura candida* Hartman.
Dodecaceria pacifica (Fewkes). Rioja, 1944. Guaymas.
**Tharyx parvus* Berkeley.
**T. tesselata* Hartman.

Flabelligeridae
Pherusa capulata (Moore). Steinbeck and Ricketts, 1941. Isla Angel de la Guarda.
P. cruca Caparède. Rioja, 1947b. La Paz.
**P. neopapillata* Hartman.
P. papillata (Johnson) Steinbeck and Ricketts, 1941; Rioja 1947a. La Paz.
P. plumosa (Müller). Rioja, 1947b. La Paz.
**Piromis gracilis* Hartman.

Opheliidae
Ammotrypane aulogaster Rathke. Rioja, 1947a. La Paz.
**Armandia bioculata* Hartman. Bahia de los Angeles.
Polyophthalmus pictus (Dujardin) Rioja, 1947a. La Paz, Topolobampo, Bahia de los Angeles.
Travisia gigas Hartman. Steinbeck and Ricketts, 1941. Cabo San Lucas, Bahia de los Angeles.
T. olens Ehlers. Fauvel, 1943. Gulf. [Perhaps *T. chinensis* Grube or *T. japonica* Fujiwara, *fide* Hartman, 1959b, p. 436].

Sternaspidae
Sternaspis major Chamberlin, 1919a. Between 27° 39′ 40″ W. Latitude and 100° 0′ 30″ N. Longitude.

Capitellidae
**Anotomastus gordiodes* (Moore).
**Capitella capitata* (Fabricius).
**Capitita ambiseta* Hartman.
Dasybranchus caducus (Grube). Steinbeck and Ricketts, 1941; Fauvel, 1943; Rioja, 1947b. La Paz, Isla San Jose, El Mogote.
D. glabrus Moore. Hartman, 1947a. Guaymas.
D. lumbricoides Grube. Hartman, 1947a. Isla Tiburon.
D. platyceps Hartman, 1947a. Estado de Sonora.
Notomastus lobatus Hartman, 1947a. Consag Rock.
**N. (Clistomastus) tenuis* Moore.

Arenicolidae
Arenicola glasselli Berkeley and Berkeley, 1939. San Felipe.
Arenicola sp.

Maldanidae
**Asychis disparidentata* (Moore).
**Axiothella rubrocincta* (Johnson).
Euclymene papillata Berkeley and Berkeley, 1939; Rioja, 1947a. Punta Penasco.
**Heteroclymene glabra* Moore.
**Maldane sarsi* Malmgren.
**Praxillella affinis pacifica* Berkeley.

Oweniidae
Owenia fusiformis delle Chiaje. Steinbeck and Ricketts, 1941. El Mogote.
**O. f. collaris* Hartman.

Sabellaridae

Idanthyrsus pennatus (Peters). Steinbeck and Ricketts, 1941. Cabo Pulmo.

Pectinariidae

Amphictene auricoma (Müller). Rioja, 1947b. La Paz.

**Pectinaria hartmanae* n. sp.

Ampharetidae

Amphicteis scaphobranchiata Moore.

**Amphisamytha bioculata* (Moore).

**Asabellides lineata* (Berkeley and Berkeley).

Sabellides delus Chamberlin, 1919a. 26° 40′ W. Latitude and 110° 45′ 20″ N. Longitude.

Terebellidae

**Amaeana occidentalis* (Hartman).

Artacama conifera Moore. Hartman, 1955. Los Frailes.

Axionice mirabilis McIntosh. Fauvel, 1943. Gulf.

Eupolymnia heterobranchia (Johnson). Rioja, 1947a. La Paz.

Loimia medusa (Savigny). Fauvel, 1943, Gulf.

L. montagui (Grube). Rioja, 1947a. La Paz.

Neoamphitrite robusta (Johnson). Fauvel, 1943; Rioja, 1947a. La Paz.

Neoleprea spiralis (Johnson). Rioja, 1947a. Topolobampo.

Nicolea latens. Chamberlin, 1919a. 26° 48′ W. Latitude and 110° 45′ 20″ N. Longitude.

Pista elongata Moore. Steinbeck and Ricketts, 1941. El Mogote.

**P. cristata* (Müller).

Polycirrus mexicanus (Rioja), 1947a. La Paz.

**P. perplexus* Moore.

Spinosphaera oculata Hartman. Rioja, 1947b. La Paz.

Terbella californica Moore. Fauvel, 1943. Gulf.

Thelepus comatus (Grube). Fauvel, 1943. Gulf.

T. crispus Johnson. Treadwell, 1937. Cabo San Lucas.

T. setosus (Quatrefages). Berkeley and Berkeley, 1939; Steinbeck and Ricketts, 1941. San Felipe, Bahia de los Angeles, Punta San Marcial.

Trichobranchidae

Terbellides stroemi Sars. Berkeley and Berkeley, 1939. Puerto San Carlos.

Sabellidae

Chone infundibuliformis fauveli McIntosh. Berkeley and Berkeley, 1939. Puerto San Carlos, Bahia de los Angeles.

C. minuta Hartman. Rioja, 1947a. La Paz.

**C. mollis* (Bush).

**Euchone barnardi*, n. sp.

**E. cortezi*, n. sp.

**Fabricia limnicola* Hartman.

Hypsicomus phaeotaenia (Schmarda). Fauvel, 1943; Rioja, 1947a. La Paz.

Megalomma mushaensis (Gravier). Steinbeck and Ricketts, 1941; Fauvel, 1943; Rioja, 1947a. La Paz, Isla Espiritu Santo, Coronados.

**M. pigmentum* Reish.

Oriopsis armandia (Claparède). Rioja, 1947a. La Paz.

Pseudopotamilla occelata Moore. Rioja, 1947b. La Paz.

Sabella melanostigma Schmarda. Fauvel, 1943. Gulf.

Serpulidae

Apomatus similis Marion and Bobretzky. Treadwell, 1937. Cabo San Lucas.

Eupomatus humilis Bush, 1904. Guaymas.

Hydroides crucigera Morch. Rioja, 1947a. La Paz. Topolobampo.

**H. recurvispina* Rioja, 1941. Rio Mayo.

Pomatoceros minutus Rioja, 1941, 1947a. Rio Mayo, Bahia de Navachiste.

Pomatoleios kraussi (Baird). Rioja, 1947a, Bahia de Navachiste, Topolobampo.

Pomatostegus stellatus (Abildgaard). Fauvel, 1943. Cabo Pulmo.

Protula superba Moore. Parker, 1963. Off mainland coast and southern limits of Gulf of California.

Protula tubularia (Montagu). Steinbeck and Ricketts, 1941. Puerto Refugio.

Salmacina dysteri (Huxley). Steinbeck and Ricketts, 1941; Fauvel, 1943. Bahia de los Angeles, Bahia de San Francisquito.

Spirobranchus giganteus (Pallas), Fauvel, 1943. La Paz, Cabo Pulmo.

S. pseudoincrassatus Bush, 1904; Steinbeck and Ricketts, 1941; Rioja, 1947a. Cabo San Lucas, Topolobampo.

Spirorbis marioni Caullery and Mesnil. Bush. 1904. Guaymas, La Paz.

Vermiliopsis cornuta Rioja, 1947b. La Paz.

TABLE 2

The relationship of the principle polychaetes to sediment type in Bahia de los Angeles, Baja California. Numerals in parentheses indicate the number of stations at which the species were collected in April 1962 and October 1963, respectively.

Species	Sand, 40 stations		Silty Sand, 46 stations		Sandy Silt, 30 stations		Silt, 45 stations	
	Percentage occurrence	Mean no. specimens per station	Percentage occurrence	Mean no. specimens per station	Percentage occurrence	Mean no. specimens per station	Percentage occurrence	Mean no. specimens per station
Pareulepis fimbriata (13-21)	30	2	27	2	17	2	—	—
Eteone dilatae (35-7)	33	2	40	2	20	3	9	1
Ophiodromus pugettensis (29-20)	40	3	39	3	27	2	17	1
Ancistrosyllis bassi (4-39)	25	2	35	2	20	2	17	1
Pilargis hamatus (26-9)	30	3	26	2	23	1	9	1
Langerhansia heterochaeta (21-16)	42	4	33	2	13	3	2	1
Ceratonereis mirabilis (32-9)	35	14	28	2	23	1	17	1
Nereis procera (27-6)	30	3	22	3	20	3	11	1
Aglaophamus dicirrus (66-84)	90	12	98	9	93	10	91	6
Glycera tesselata (20-35)	48	30	37	5	20	1	29	1
Glycinde armigea (57-56)	63	11	76	4	80	4	65	4
Onuphis zebra (60-76)	63	9	85	6	97	13	96	10
Lumbrineris minima (57-20)	60	9	52	5	50	3	29	2
Haploscoloplos elongatus (58-54)	75	18	83	22	83	11	42	4
Aricidea rosea	15	17	35	76	63	87	53	100
Polydora socialis plena (27-22)	35	3	33	1	37	4	20	1
Prionospio cirrifera (46-62)	40	5	57	12	83	12	91	12
P. pinnata (36-60)	83	11	80	16	53	7	22	1
P. pygmaeus (51-4)	20	9	26	18	60	18	38	16
Magelona californica (14-30)	73	10	30	24	3	1	—	—
Telepsavus costarum (43-23)	55	4	56	3	4	5	18	1
Chaetozone corona (49-32)	70	40	72	11	33	6	22	3
Cossura candida (40-42)	5	1	39	2	67	6	94	12
Tharyx parvus (58-47)	65	21	85	28	67	9	44	2
Armandia bioculata (31-15)	42	13	26	3	27	7	40	2
Capitita ambiseta (67-54)	62	147	72	255	83	182	84	52
Heteroclymene glabra (37-1)	27	19	22	9	27	6	20	5
Praxillella affinis pacifica (54-32)	68	20	67	11	47	14	31	2
Amaeana occidentalis (33-11)	25	15	22	6	53	4	18	1
Chone mollis (54-14)	50	11	43	9	43	9	33	3
Euchone barnardi (35-3)	15	27	19	10	40	15	24	23
Megalomma pigmentum (22-13)	30	2	39	3	10	1	2	1

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A BIOLOGICAL SURVEY OF BAHIA DE LOS ANGELES, GULF OF CALIFORNIA, MEXICO. III. BENTHIC MOLLUSCA

EUGENE V. COAN

TRANSACTIONS

OF THE SAN DIEGO
SOCIETY OF
NATURAL HISTORY

VOL. 15, NO. 8, 25 SEPTEMBER 1968

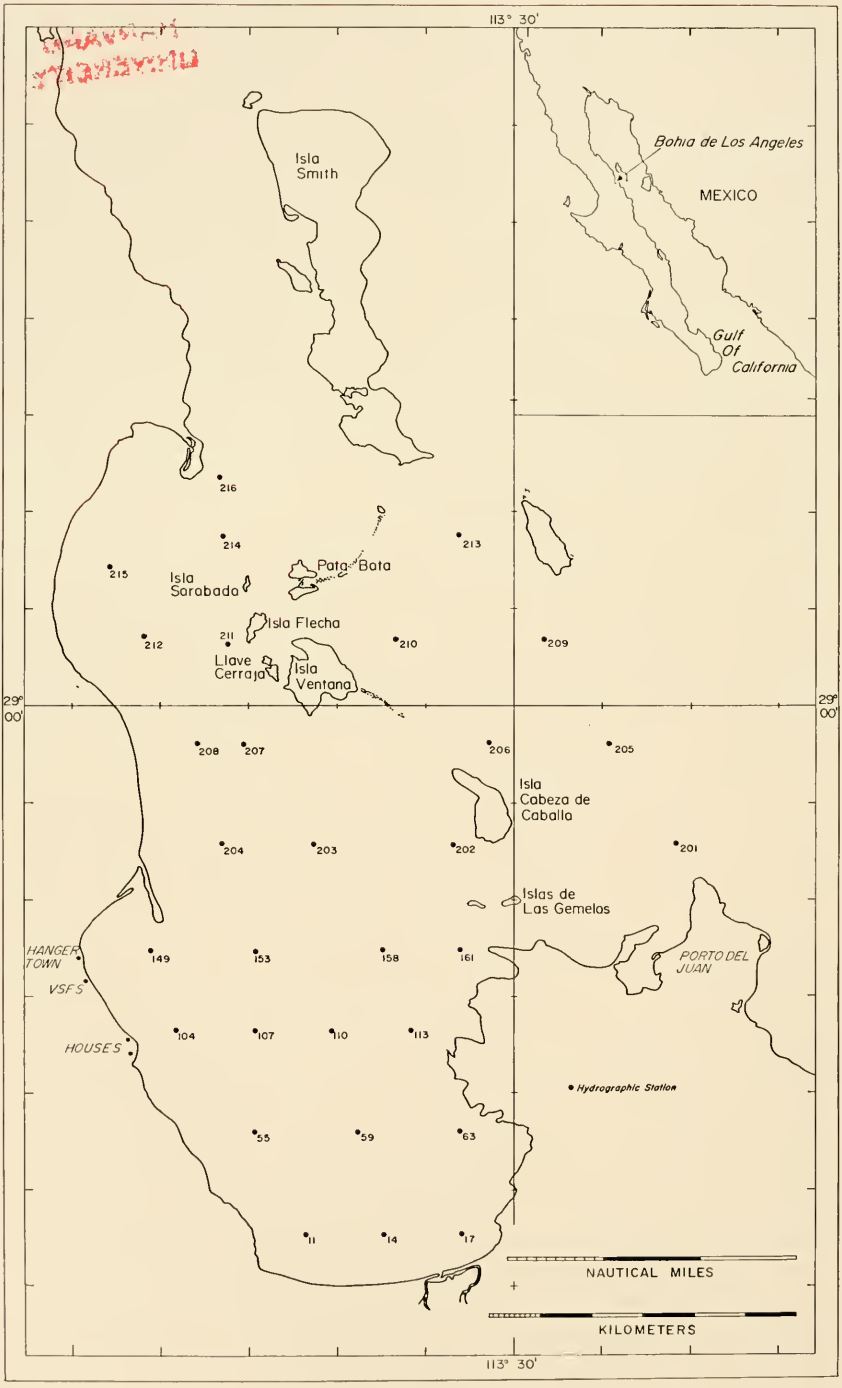

Figure 1. Map of Bahía de los Angeles. Inset, location of bay in Gulf of California.

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A BIOLOGICAL SURVEY OF BAHIA DE LOS ANGELES, GULF OF CALIFORNIA, MEXICO. III. BENTHIC MOLLUSCA

Eugene V. Coan

Abstract. Benthic mollusks were collected by the Beaudette Foundation at Bahía de los Angeles, Baja California, Mexico, in April 1962, and October 1963. Samples were obtained with an orange-peel grab at 161 stations. April collections were sparse, but October samples were even sparser. The depletion may result from seasonal predation by bottom-dwelling fishes. Fewer species and specimens were found with increasing water depth, and with the exception of a few shallow water localities near the head of the bay, the molluscan fauna is considered to represent a single assemblage characterized by the genera *Tellina, Cadulus* and *Nuculana*. This assemblage is thought to be typical of silty-sand substrates in semi-protected bays in tropical and subtropical areas. The fauna of Bahía de los Angeles is characteristic of the Panamic Province and is most similar to faunas found farther south in the Gulf of California.

Resumen. En la Bahía de los Angeles, Baja California, México, se recolectaron moluscos bénticos durante los meses de Abril 1962 y Octubre 1963. Estas colecciones fueron patrocinadas por la Fundación Beaudette. Las muestras corresponden a 161 estaciones, y fueron recogidas con unas tenazas de cuatro cucharas o sectores. Las colecciones correspondientes al mes de Abril fueron pobres, y las de Octubre resultaron aún más deficientes. Esta escasez de moluscos se debe probablemente a la predación que efectuan los peces de fondo durante ciertas estaciones. A mayor profundidad el número de especies y de ejemplares por especies era menor. La fauna malacológica, excepto en las zonas más internas de la bahía, estaba representada por los géneros *Tellina, Cadulus* y *Nuculana*. Este complejo malacológico se considera típico de los substratos de arenas salobres en bahías semi-protegidas de las regiones tropicales y subtropicales. La fauna de la Bahía de los Angeles es característica de la provincia Panameña, y es muy similar a la fauna que se presenta más al sur en el Golfo de California.

This report deals with the benthic mollusks collected by the Beaudette Foundation of California at Bahía de los Angeles, Gulf of California, Mexico, in April 1962 and October 1963. A preliminary report on these collections has been presented elsewhere (Coan, 1964). A list of mollusks obtained from shore and beach-drift collections has been published by McLean (1961).

Methods

A detailed description of sampling methods is given by Barnard and Grady (1968). Briefly, a grid of 161 sampling stations was established in the southern portion of the bay (Fig. 1; see also Reish, 1968, Fig. 1). Samples were collected with an orange-peel grab that covered approximately 0.06m^2 of bottom surface. In general, alternate stations were sampled in April 1962, the remaining stations in October 1963. However, several stations were sampled in both periods, and stations 1 through 8 were sampled only in October. With the following two exceptions, one sample was made at each station: two samples, preserved separately, were made at Station 158 in April; two samples, combined, were made at Station 130 in April. These exceptions were taken into consideration in the computations.

Several non-quantitative samples were also made by the Beaudette Foundation and by an expedition of the Scripps Institution of Oceanography, both in April 1962. The material is not included in the analysis, but the species are reported in the Systematic List and in the discussion of geographic ranges. Detailed information on sampling procedures at these stations is presented in Barnard and Grady (1968, Tables 2, 3).

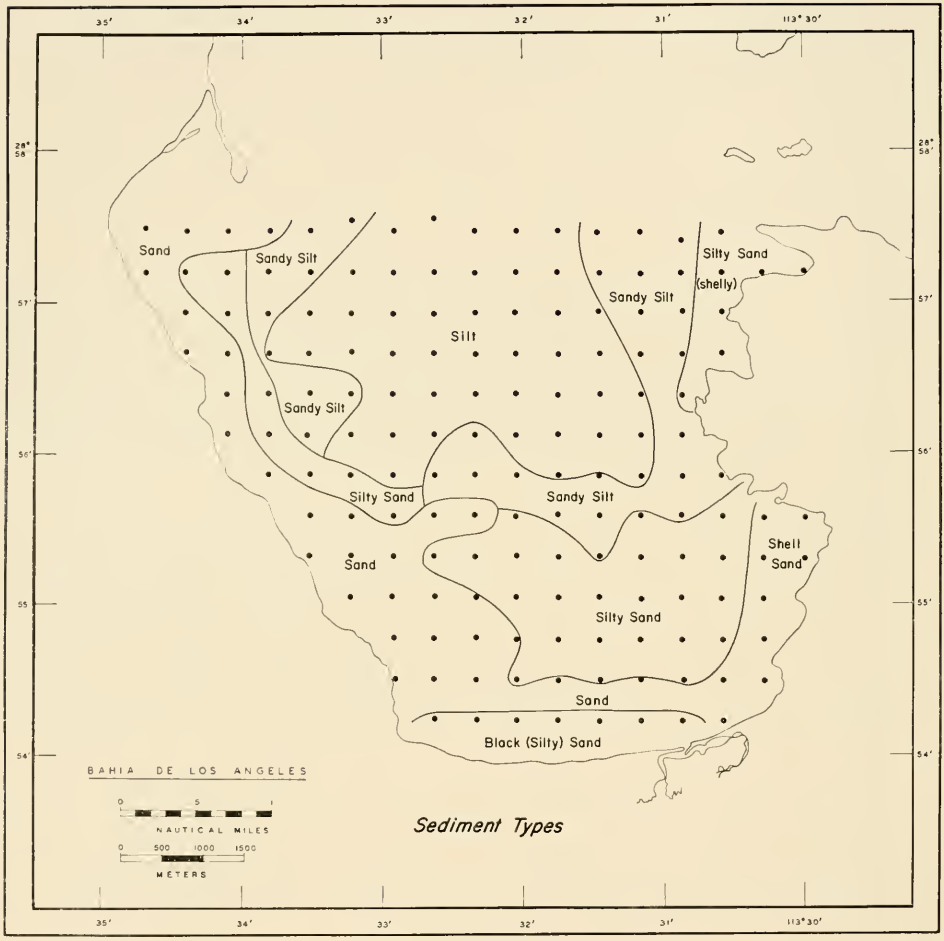

Figure 2. Sediment distribution in south portion of Bahia de los Angeles.

The material collected was sorted to phylum. Species represented only by shells were removed from the molluscan samples to minimize possible contamination by organisms that may have drifted from elsewhere. With small specimens this separation was difficult, and some dead organisms may have been inadvertently included in the analyses. After the material was air-dried, the distinction between live-collected and dead shells could not be made as easily.

The physical features of the bay are discussed by Barnard and Grady (1968). Figure 2 shows the major benthic sediment patterns for comparison with the distributions of the species discussed.

Discussion. — Several potential sources of sampling error are not excluded by the techniques employed. Use of an orange-peel grab virtually precluded the collection of some deep-burrowing mollusks, and the depth of grab penetration varies with sediment properties. Because of the large number of samples taken, some deep-burrowing species may be represented. Future studies should utilize large grabs to supplement smaller ones.

While the rigid grid pattern results in uniform sampling areally, it does not necessarily provide sufficient data for charting precise distributional patterns. For example, high gradient slopes were not sampled effectively because of their small areal representation. The distributional patterns of some mollusks reflect this because their depth habitats were not sampled on the more steeply-sloping eastern side of the bay. Species that may be especially abundant on such slopes — their distributions being more strongly correlated with degree of slope than with depth or sediment type — may not have been collected.

There is a lack of quantitative samples from depths shallower than 10m. A few shallow-water grabs were made from a skiff, but there are obvious difficulties in taking samples with a relatively large device from a small boat. Parker (1964a, b) has mentioned decided differences between intertidal sandy beach assemblages and off-shore shallow-water assemblages in the Gulf of California. At Bahía de los Angeles there appears to be a distinct shallow-water fauna at some stations, especially numbers 1 through 8, but the samples are too few to be conclusive.

Discussion

Differences between sampling periods. — Fewer mollusks than expected were collected in the April survey. From 76 samples, 4060 individuals representing 126 species were collected; in general, the specimens appeared to be juveniles. In October, only 97 species and 1832 individuals were collected from 91 samples; a wider range of specimen sizes seemed to occur in this period, but no quantitative measure of this was made. Thus, there was striking depletion of the bay fauna. Several shallow-water species were collected in October but not in April; two of these occurred in relatively large numbers.

The causes of this depletion are not known. It might result from annual or seasonal changes in water temperature, sediment deposition patterns, behavior of the organisms, action of bottom-feeding fishes, unsuspected changes in sampling techniques and grab operation, or even from random variation. Too little data are available to resolve this question. However, there are features of the depletion that may be pertinent. I noted that the remains of dead animals were not found in greater abundance in the October sample. If the depletion resulted from *in situ* death, one would expect — barring other complications such as burying, sediment shift, and decomposition — to find more residual shells in October.

The change in the distributional pattern of species may also be instructive (Table 1). Twenty-seven species were collected in quantities of thirty or more individuals in the quantitative sampling. Eighteen showed a decrease in numbers in the October sample, and in ten of these the decrease seemed to be greater toward the mouth of the bay, though not necessarily in deep water. Possibly predation is greater offshore than near shore, where tidal variation, turbulence, and temperature extremes may deter predaceous fishes. The tendency for forms to decrease offshore, however, cannot account for the virtual disappearance of some fairly common species (*e.g.*, *Nuculana acrita*). The problem is worthy of further research.

Bathymetric distribution. — The April data indicate an inverse relationship between the numbers of species and specimens per sample and water depth. (The October data were not analyzed in this manner.) A rather sharp break occurred at approximately 30m. About 17 species and 90 specimens per station were taken from depths of less than 30m, nine species and 30 specimens at greater depths. Keen (1964) reported that the number of specimens at 40m at Isla Espíritu Santo, Gulf of California, was greater than at 20m, but she included both living and non-living material.

Table 1

Changes in abundance of Mollusca between sampling periods

Species showing an apparent increase in numbers

a) due to near-shore sampling in October: *Transennella humilis; Caecum* sp.; *Micranellum* sp.; *Elephantulum* cf. *E. liratocinctum; Nassarius tiarula; Acteocina angustior.*

b) due to greater number of unidentifiable juveniles: *Tellina* sp.

Species showing little changes in numbers and

a) little change in distribution: *Transennella sororcula.*

b) decrease off shore (increase due to near-shore sampling): *Tellina arenica.*

Species showing little change in numbers and

a) almost complete disappearance: *Nuculana acrita; Mysella* cf. *M. chalcedonica; Dentalium innumerabile* (a deep-water form); *Solariorbis liriope* (a deep-water form).

b) a uniform decrease throughout the bay: *Nucula declivis; Crenella ecuadoriana; Mangelia cyrene; Acteocina infrequens.*

c) a greater decrease off shore: *Nucinella subdola; Lucina mazatlanica; Diplodonta sericata; Laevicardium elenense; Chione gnidia; Lyonsia gouldii; Solemya valvulus; Cadulus panamensis; Alabina excurvata; Acteocina carinata.*

The Bay-wide Community. — A computer study, made under the direction of Dr. James Rohlf, indicated that the fauna of the bay was not divisible into distinct associations or communities. Thus, with the exception of the small shallow-water fauna taken only in October 1963, which seems to be distinct, the mollusks obtained in this study are considered to represent a single community. Parker (1964a, b) concluded that for the Gulf of California in general there is a sharp faunal division at 26m. No such division was found in the present study, although the number of species declines at depths of over 30m. There is, however, a gradational decrease in mollusk abundance toward the mouth of the bay.

Table 2 lists the commonest mollusks collected during the survey. The three most abundant forms, *Tellina arenica, Cadulus panamensis,* and *Nuculana acrita* are found throughout the bay (see Systematic List). Few of the species which Parker (1964a, b) lists as characteristic of 11-26m or 26-65m depths were found in this study, but his samples were from a wide area of the Gulf of California. Also, a greater variety of depths and environments were sampled, and the sampling regions did not include bays as protected as Bahía de los Angeles.

The *Tellina-Cadulus-Nuculana* assemblage does not correspond with assemblages described by Thorson (1957) for arctic and sub-arctic regions. Parker (1960) noted associations in the Gulf of Mexico which are somewhat similar to that at Bahía de los Angeles. The fauna at Isla Espíritu Santo (Keen, 1964) is quite different, perhaps because the substrate in the area is coarse coral sand. I suspect that the *Tellina-Cadulus-Nuculana* assemblage may be typical of sandy-silt substrates in semi-protected bays. Mr. Barry Roth and I found that these three genera were the most abundant in the harbor at Princeton, San Mateo County, California, in August 1962 and July 1964, though the species represented all differed from those at Bahía de los Angeles.

TABLE 2

Relative abundance of common Mollusca in Bahía de los Angeles, April and October samples combined. A density estimate (no. specimens / m^2) is given for the commonest species.

Tellina arenica, 998 (95.5); *Cadulus panamensis*, 679 (65.0); *Nuculana acrita*, 660 (63.2); *Acteocina carinata*, 432 (40.5); *Nassarius tiarula*, 276 (26.4); *Diplodonta sericata*, 215 (20.6); *Solemya valvulus*, 178; *Lyonsia gouldii*, 163; *Nucinella subdola*, 152; *Caecum* sp., 151; *Mysella* cf. *M. chalcedonica*, 150; *Alabina excurvata*, 143; *Nucula declivis*, 117; *Micranellum* sp., 115; *Crenella ecuadoriana*, 107; *Dentalium innumerabile*, 72; *Transennella humilis*, 70; *Elephantulum* cf. *E. liratocinctum*, 69; *Tellina* sp. (unidentifiable juvs.), 62; *Laevicardium elenense*, 59; *Acteocina angustior*, 59; *Transennella sororcula*, 51; *Acteocina infrequens*, 50; *Solariorbis liriope*, 48; *Mangelia cyrene*, 47; *Chione gnidia*, 43; *Lucina mazatlanica*, 39.

Biogeographic considerations. — Of the 177 identifiable species encountered in this study, 154 do not range into California but may extend northward on the west coast of Baja California. Very few, however, occur north of Bahía Magdalena. Of 23 forms which do range to California, 19 also extend farther south than the tip of Baja California. Of 47 species encountered that occur only in the Gulf of California, 28 do not occur north of Bahía de los Angeles. This is surprising because the salinity and water temperatures at the head of the Gulf are similar to those of Bahía de los Angeles.

SYSTEMATIC LIST

A systematic list of species collected in both the quantitative and non-quantitative sampling is given below. The material collected is analyzed by time of collection, and the depth range and main distribution within the area of quantitative sampling (or outside this area) is given for each species. The following abbreviations are used: C = central; E = east; f.= figure(s); int. = intertidal; N = north; pl. = plate(s); s = scattered; S = south; sub = subtidal; W = west; * = probably new species.

The material collected is housed in the Department of Geology, Stanford University, California, under the collection numbers 50306-50489. For a complete Station list of specimens order NAPS Document 0083 from ASIS National Auxiliary Publications Service, c/o CCM Information Sciences, Inc., 22 West 34th Street, New York, N.Y. 10001; remitting $1 for each microfiche copy and $3 for each hard-copy reproduction.

SYSTEMATIC LIST

BIVALVIA

FAMILY and Species	References	April 1962 No. species taken at (no. stations)	April 1962 Other specimens (non-quant. material)	October 1963 No. species taken at (no. stations)	Depth range, m., and (area of greatest abundance)	Main distribution
SOLEMYACIDAE						
Solemya valvulus Carpenter, 1864	Keen, 1958: 236, f. 606. Palmer, 1963: 301.	102 (29)		76 (21)	3-42	S, NW
NUCULIDAE						
Nucula declivis Hinds, 1843	Keen, 1958: 16, f. 1. Olsson, 1961: 55; pl. 1, f. 4, 4a.	76 (23)	3	41 (19)	3-38	S, W
Nucula exigua Sowerby, 1833	Keen, 1958: 16, f. 2. Olsson, 1961: 56; pl. 1, f. 2-2b, 10, 10a.	1 (1)			38	W
Nucula schencki Hertlein & Strong, 1940	Keen, 1958: 16, f. 4. Olsson, 1961: 56; pl. 1, f. 6.	3 (2)			25-44	W, C
NUCULANIDAE						
Nuculana elenensis (Sowerby, 1833)	Keen, 1958: 18, f. 10. Olsson, 1961: 63; pl. 1, f. 9.	4 (4)			13-37	s
Nuculana acrita (Dall, 1908)	Olsson, 1961: 60; pl. 2, f. 7. Keen, 1958: 19, f. 13, as *N. laeviradius* Pilsbry & Lowe.	659 (63)		1 (1)	6-46 (20-40)	S, NW
NUCINELLIDAE						
Nucinella subdola (Strong & Hertlein, 1937)	Keen, 1958: 24, f. 34. Olsson, 1961: 72; pl. 17, f. 12.	128 (34)	1	24 (12)	3-46 (20-40)	S, NW
ARCIDAE						
Arcopsis solida (Sowerby, 1833)	Keen, 1958: 30, f. 46. Olsson, 1961: 85; pl. 6, f. 3-3b.		1		3	off Isla Ventana
Anadara tuberculosa (Sowerby, 1833)	Keen, 1958: 32, f. 50. Olsson, 1961: 87; pl. 7, f. 3, 3a.		1		9-32	NW
Anadara multicostata (Sowerby, 1833)	Keen, 1958: 34, f. 57. Olsson, 1961: 92; pl. 7, f. 5; pl. 9, f. 6.	6 (5)	5		9-41	W

Anadara reinharti (Lowe, 1935)	Keen, 1958: 38, f. 65. Olsson, 1961: 100; pl. 8, f. 4; pl. 9, f. 1; pl. 10, f. 4-4d.	1 (1)			36	W
GLYCYMERIDAE						
Glycymeris sp. (unidentifiable juv.)				1 (1)	14	—
Glycymeris maculata (Broderip, 1832)	Keen, 1958: 42, f. 75. Olsson, 1961: 106; pl. 11, f. 2, 5.			5 (2)	4-9	W
MYTILIDAE						
Septifer zeteki Hertlein & Strong, 1946	Keen, 1958: 50, f. 87. Olsson, 1961: 122; pl. 13, f. 7, 7a.		1		3	off Isla Ventana
Crenella ecuadoriana Pilsbry & Olsson, 1941	Olsson, 1961: 130; pl. 17, f. 7, 7a. Keen, 1958: 50, f. 88, as *C. divaricata* (d'Orbigny).	97 (16)	7	10 (6)	3-49 (20-45)	S, W
Lithophaga aristata (Dillwyn, 1817)	Keen, 1958: 52, f. 90. Olsson, 1961: 137; pl. 16, f. 2-2c.		2		int.	W
Gregariella chenui (Récluz, 1842)	Keen, 1958: 54, f. 97. Olsson, 1961: 129.		1		3	off Isla Ventana
Modiolus cf. *M. pseudotulipus* Olsson, 1961	Olsson, 1961: 127; pl. 14, f. 2, 2a. Keen, 1958: 54, f. 100, as *M. americanus* (Leach).	1 (1)			30	SW
PTERIIDAE						
Pteria sterna (Gould, 1851)	Keen, 1958: 58, f. 107. Olsson, 1961: 146; pl. 18, f. 4. Johnson, 1964: 152.	24 (5)			13-36	S
PECTINIDAE						
Pecten vogdesi Arnold, 1906	Keen, 1958: 70, f. 126. Olsson, 1961: 158; pl. 20, f. 4-4b.	1 (1)			17	S
Acquipecten circularis (Sowerby, 1835)	Keen, 1958: 72, f. 132. Olsson, 1961: 163; pl. 19, f. 2-2b.	2 (2)		1 (1)	9-37	W, C
Cyclopecten pernomus (Hertlein, 1935)	Keen, 1958: 72, f. 135. Olsson, 1961: 168; pl. 21, f. 6.	4 (2)	604		int.-45	NW, also N of quant. area
LIMIDAE						
Lima sp. (unidentifiable juvs.)			3		int.-3	—
Lima cf. *L. similaris* Dall, 1908	Keen, 1958: 76.	2 (2)			33-42	C

FAMILY and Species	References	April 1962 No. species taken at (no. stations)	April 1962 Other specimens (non-quant. material)	October 1963 No. species taken at (no. stations)	Depth range, m., and (area of greatest abundance)	Main distribution
CRASSATELLIDAE						
Crassatella digueti Lamy, 1917	Keen, 1958: 82, f. 157. Olsson, 1961: 180; pl. 25, f. 2.	11 (10)	1	1 (1)	15-37	W
CARDITIDAE						
Cardita megastropha (Gray, 1825)	Keen, 1958: 86, f. 166. Olsson, 1961: 187; pl. 26, f. 5, 5a.		1	2 (2)	3-6	NE, NW, edges
CONDYLOCARDIIDAE						
Condylocardia digueti Lamy, 1916	Keen, 1958: 86, f. 170. Olsson, 1961: 180; pl. 25, f. 2.		1		3	off Isla Ventana
LUCINIDAE						
Lucina cancellaris Phillippi, 1846	Keen, 1958: 94, f. 184. Olsson, 1961: 211; pl. 31, f. 4-4b.	9 (6)	2	2 (2)	6-22	S, edges
Lucina lingualis Carpenter, 1864	Keen, 1958: 94, f. 186. Olsson, 1961: 211; pl. 31, f. 11. Palmer, 1963: 304; pl. 59, f. 1-5.	1 (1)		3 (1)	4-7	W
Lucina fenestrata Hinds, 1845	Keen, 1958: 94, f. 189. Olsson, 1961: 213; pl. 29, f. 10. Keen, 1966a: 267, f. 1.			1 (1)	24	S
Lucina liana (Pilsbry, 1931)	Keen, 1958: 95, f. 190. Olsson, 1961: 212; pl. 29, f. 9, 9a.	25 (17)		3 (3)	9-37 (20-35)	S, NW
Lucina approximata (Dall, 1901)	Keen, 1958; 96, f. 192. Olsson, 1961: 214; pl. 31, f. 7.	4 (4)			25-36	C
Lucina mazatlanica Carpenter, 1855	Keen, 1958: 96, f. 193. Olsson, 1961: 214; pl. 31, f. 3-3b, 9, 9a. Keen, 1968: 396; pl. 56, f. 29a, b; f. 5a-c.	32 (21)	1	7 (7)	7-46	s
Ctena mexicana (Dall, 1901)	Keen, 1958: 100, f. 205. Olsson, 1961: 218; pl. 29, f. 5.	7 (7)		7 (6)	24-38	S, NW
Divalinga eburnea (Reeve, 1850)	Keen, 1958: 100, f. 206. Olsson, 1961: 220; pl. 31, f. 2.			1 (1)	7	S

DIPLODONTIDAE						
Diplodonta sericata (Reeve, 1850)	Keen, 1958: 103, f. 212. Olsson, 1961: 203; pl. 32, f. 1-1b, as *D. cornea* (Reeve).	178 (38)		37 (22)	2-40 (2-30)	S, NW
THYASIRIDAE						
Thyasira sp.*		18 (17)			21-41	S, W
MONTACUTIDAE						
Mysella sp. (unidentifiable juvs.)				3 (3)	9-22	—
Mysella cf. *M. chalcedonica* (Carpenter, 1857)	Keen, 1958: 107. Keen, 1968: 397, f. 8.	150 (29)			7-46 (15-30)	S, NW
Mysella compressa (Dall, 1913)	Keen, 1958: 107, f. 231. Olsson, 1961: 234; pl. 35, f. 10.	1 (1)			13	S
CARDIIDAE						
Trigoniocardia biangulata (Broderip & Sowerby, 1829)	Keen, 1958: 118, f. 258. Olsson, 1961: 251; pl. 37, f. 6, 6a.	1 (1)	1		7-17	NW
Laevicardium elenense (Sowerby, 1840)	Keen, 1958: 120, f. 263. Olsson, 1961: 256; pl. 38, f. 2, 2a.	35 (1)	2	24 (13)	3-42 (3-20)	S, NW
VENERIDAE						
Transennella sororcula Pilsbry & Lowe, 1932	Keen, 1958: 128, f. 281. Olsson, 1961: 280-281; pl. 46, f. 4-4b, as *T. modesta* (Sowerby), in part.	27 (2)	11	24 (7)	4-13	S, W
Transenella humilis (Carpenter, 1857)	Keen, 1968: 398; pl. 55, f. 17a-c. Keen, 1958: 128, f. 282, as *T. tantilla* (Gould).	6 (5)	3	64 (3)	int.-24	S
Pitar sp. (unidentifiable juvs.)		1 (1)		4 (4)	4-21	—
Pitar cf. *P. newcombianus* (Gabb, 1865)	Keen, 1958: 129, f. 286.	8 (7)			15-30	S, W
Pitar cf. *P. perfragilis* Pilsbry & Lowe, 1932	Keen, 1958: 129, f. 287.	3 (3)			15-25	S, W
Megapitaria squalida (Sowerby, 1835)	Keen, 1958: 134, f. 303. Olsson, 1961: 273; pl. 46, f. 2-2c.	1 (1)			17	S
Dosinia ponderosa (Gray, 1838)	Keen, 1958: 136, f. 306. Olsson, 1961: 260; pl. 40, f. 5; pl. 42, f. 1-1c; pl. 43, f. 1.	9 (6)	1	2 (2)	6-19	S, NW

FAMILY and Species	References	April 1962 No. species taken at (no. stations)	Other specimens (non-quant. material)	October 1963 No. species taken at (no. stations)	Depth range, m., and (area of greatest abundance)	Main distribution
Cyclinella singleyi Dall, 1902	Keen, 1958: 138, f. 309. Olsson, 1961: 265; pl. 43, f. 5, 5a.	3 (3)		1 (1)	15-40	C
Chione sp. (unidentifiable juvs.)		5 (3)		1 (1)	5-22	—
Chione amathusia (Philippi, 1844)	Keen 1958: 143, f. 324. Olsson, 1961: 299; pl. 41, f. 7; pl. 51, f. 1, 1a; pl. 84, f. 2.			3 (1)	22	E
Chione gnidia (Broderip & Sowerby, 1829)	Keen, 1958: 144, f. 326. Olsson, 1961: 300; pl. 49, f. 1, 1a.	28 (18)	1	15 (9)	3-42 (10-30)	S, NW
Chione mariae (d'Orbigny, 1846)	Keen, 1958: 146, f. 331. Olsson, 1961: 296; pl. 49, f. 2, 8, 8a. Keen, 1966c: 6.	6 (6)		1 (1)	15-41	W
Timoclea squamosa (Carpenter, 1855)	Olsson, 1961: 309; pl. 49, f. 10. Keen, 1968: 399; pl. 55, f. 13a, b; f. 15.		2		3	off Isla Ventana
TELLINIDAE						
Tellina sp. (unidentifiable juvs.)		5 (3)		57 (6)	3-46	—
Tellina pacifica Dall, 1900	Keen, 1958: 165, f. 373.		1		3	off Isla Ventana
Tellina simulans C. B. Adams, 1852	Keen, 1958: 168, f. 384. Olsson, 1961: 396; pl. 71, f. 1, 1a.			1 (1)	18	SE
Tellina lyrica Pilsbry & Lowe, 1932	Keen, 1958: 168, f. 386. Olsson, 1961: 384; pl. 70, f. 6, 6a.	23 (9)	1	4 (3)	7-44 (7-30)	S, W
Tellina reclusa Dall, 1900	Keen, 1958: 170, f. 391.			1 (1)	6	NE
Tellina sp.*		19 (2)	2		6-7	NW
Tellina amianta Dall, 1900	Keen, 1958: 170, f. 392.	6 (4)	11		13-17	S, W
Tellina arenica Hertlein & Strong, 1949	Keen, 1958: 170, f. 393.	486 (44)	1	512 (37)	2-46 (2-30)	S, NW
Tellidora burneti (Broderip & Sowerby, 1829)	Keen, 1958: 184, f. 442. Olsson, 1961: 381; pl. 69, f. 1-1b.	2 (2)		1 (1)	11-17	S, W, edges

PSAMMOBIIDAE						
Tagelus politus (Carpenter, 1857)	Keen, 1958: 194, f. 475. Olsson, 1961: 352; pl. 62, f. 7, 7a. Keen, 1968: 399; pl. 56, f. 27.	14 (13)	1	1 (1)	7-46 (23-46)	C
SEMELIDAE						
Semele sp. (unidentifiable juv.)		1 (1)			25	—
Semele pacifica Dall, 1915	Keen, 1958: 198, f. 489. Olsson, 1961: 368; pl. 65, f. 3.	3 (3)	3	2 (2)	int.-38	s
SOLENIDAE						
Solen pazensis Lowe, 1935	Keen, 1958: 204, f. 514.	1 (1)			7	SE
CORBULIDAE						
Corbula fragilis Hinds, 1843	Keen, 1958: 210, f. 537. Keen, 1966a: 268; pl. 46, f. 3.	1 (1)			7	SE
HIATELLIDAE						
Hiatella arctica (Linnaeus, 1767)	Keen, 1958: 212, f. 542.		3		int.-9	N of quant. area
PANDORIDAE						
Pandora convexa Dall, 1915	Keen, 1958: 226, f. 575. Olsson, 1961: 455; pl. 81, f. 7, 7a. as *P. cornuta* C. B. Adams, in part.	7 (3)			21-30	S
LYONSIIDAE						
Lyonsia gouldii Dall, 1915	Keen, 1958: 227, f. 578.	154 (45)	21	9 (7)	4-42 (10-30)	S NW
THRACIIDAE						
Thracia squamosa Carpenter, 1856	Palmer, 1963: 320; pl. 63, f. 16, 17. Keen, 1968: 434; pl. 56, f. 32.	6 (6)			15-44	s
Cyathodonta undulata Conrad, 1849	Keen, 1958: 232, f. 595. Olsson, 1961: 459.	2 (2)			6-17	W
CUSPIDARIIDAE						
Cuspidaria costata (Sowerby, 1834)	Olsson, 1961: 465; pl. 83, f. 6, 6a. Keen, 1958: 234, f. 598, as *C. dulcis* Pilsbry & Lowe.	7 (6)			17-46	W, C

FAMILY and Species	References	April 1962 No. species taken at (no. stations)	April 1962 Other specimens (non-quant. material)	October 1963 No. species taken at (no. stations)	Depth range, m., and (area of greatest abundance)	Main distribution
SCAPHOPODA						
DENTALIIDAE						
Dentalium sp. (unidentifiable)				1 (1)	46	—
Dentalium innumerabile Pilsbry & Sharp, 1897	Keen 1958: 238, f. 1.	72 (21)			30-46	C, outer
Dentalium inversum Deshayes, 1826	Keen, 1958: 238, f. 2.			1 (1)	37	C
Dentalium oerstedii Mörch, 1860	Keen, 1958: 238, f. 3. Keen, 1966b: 18, f. 21.	27 (15)		1 (1)	21-40	S, NW
Dentalium numerosum Pilsbry & Sharp, 1897	Keen, 1958: 238, f. 4.	5 (5)		1 (1)	19-42	s
Dentalium semipolitum Broderip & Sowerby, 1829	Keen, 1958: 238, f. 6.	2 (2)			13-21	S
Dentalium splendidum Sowerby, 1832	Keen, 1958: 239, f. 7.	7 (6)			30-38	C, outer
Dentalium hancocki Emerson, 1956	Keen, 1958: 239, f. 8.			1 (1)	29	NW
Dentalium quadrangulare Sowerby, 1832	Keen, 1958: 240, f. 9.	2 (2)	1		15-17	NW
SIPHONODENTALIIDAE						
Cadulus panamensis Pilsbry & Sharp, 1897	Keen, 1958: 240, f. 12.	647 (60)		32 (23)	13-45 (15-32)	S, NW
GASTROPODA						
FISSURELLIDAE						
Diodora alta (C. B. Adams, 1852)	Keen, 1958: 251, f. 30.		1		3	off Isla Ventana
TROCHIDAE						
Calliostoma sp. (unidentifiable juv.)		1 (1)			37	—

Calliostoma angelenum Lowe, 1935	Keen, 1958: 254, f. 38.		1		sub.	NE
Tegula mariana Dall, 1919	Keen, 1958: 258, f. 54.		1		int.	—
TURBINIDAE						
Turbo saxosus Wood, 1828	Keen, 1958: 262, f. 67.		1		sub.	NW
Arene sp.*				1 (1)	49	NE
Arene hindsiana Pilsbry & Lowe, 1932	Keen 1958: 264, f. 77.			1 (1)	18	NE
PHASIANELLIDAE						
Tricolia sp. (unidentified)		3 (1)	14	3 (2)	4-9	s, edges
PHENACOLEPADIDAE						
Phenacolepas malonei Vanatta, 1912	Keen, 1958: 267, f. 85.		4		sub.-9	—
EULIMIDAE						
Eulima or *Balcis* spp. (unidentified)		2 (2)		9 (5)	4-40	—
Balcis drangai Hertlein & Strong, 1951	Hertlein & Strong, 1951: 91; pl. 6, f. 2.		1		int.	off Isla Ventana
Balcis cf. *B. micans* (Carpenter, 1864)	Bartsch, 1917b: 303; pl. 34, f. 1-6. Palmer, 1958: 195.	1 (1)			35	W
Balcis cf. *B. recta* (C. B. Adams, 1852)	Bartsch, 1917b: 311; pl. 39, f. 3. Turner, 1956: 79.	3 (2)			6-7	NW
Balcis cf. *B. townsendi* (Bartsch, 1917)	Bartsch, 1917b: 323; pl. 40, f. 1.			2 (2)	27-33	C
Niso excolpa Bartsch, 1917	Keen, 1958: 268, f. 87.	1 (1)			46	NF
EPITONIIDAE						
Epitonium vitesi Hertlein & Strong, 1951	Keen, 1958: 272, f. 98.	1 (1)		1 (1)	7-9	SF

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LITTORINIDAE						
Littorina sp. (unidentifiable)		1 (1)			16	—
Littorina sp.*			1	2 (2)	3-5	S & off Isla Ventana
TORNIDAE						
Aorotrema humboldti (Hertlein & Strong, 1951)	Hertlein & Strong, 1951: 110; pl. 10, f. 1.	1 (1)			21	S
Vitrinella sp. (unidentified)		1 (1)			25	SW
Solariorbis liriope (Bartsch, 1911)	Bartsch, 1911a: 231; pl. 40, f. 7-9. Pilsbry & Olsson, 1952: 52.	46 (13)		2 (2)	17-49 (25-49)	C
Teinostoma sp. (unidentifiable)				1 (1)	6	—
Teinostoma cf. *T. concavaxis* Pilsbry & Olsson, 1945	Pilsbry & Olsson, 1945: 254; pl. 23, f. 4-4b.	1 (1)			7	SE
Teinostoma herbertianum Hertlein & Strong, 1951	Hertlein & Strong, 1951: 112; pl. 9, f. 8, 11, 12.	1 (1)			16	SE
RISSOIDAE						
Alvania monserratensis Baker, Hanna, & Strong, 1930	Baker, Hanna, & Strong 1930: 27; pl. 1, f. 9.		1		3	off Isla Ventana
Alvania tumida Carpenter, 1856	Bartsch 1911d: 361; pl. 32, f. 2. Keen, 1968: 415, f. 68.	2 (2)	1	2 (2)	4-46	s
Barleeia alderi (Carpenter, 1856)	Bartsch, 1920: 175; pl. 12, f. 6. Keen, 1968: 418, f. 72.		18	10 (3)	sub.-9	NE, NW
Barleeia orcutti Bartsch, 1920	Bartsch, 1920: 174; pl. 13, f. 8. Baker, Hanna, & Strong, 1930: 39, f. 2.		1		3	off Isla Ventana
RISSOINIDAE						
Rissoina (*Folinia*) sp.*			1		3	off Isla Ventana
Rissoina (*Zebinella*) sp.*		1 (1)			30	C

Rissoina signae Bartsch, 1915	Bartsch, 1915: 61; pl. 31, f. 1, 4.		1		3	off Isla Ventana
Rissoina mexicana Bartsch, 1915	Bartsch, 1915: 56; pl. 33 f. 6.		2		int.	—
RISSOELLIDAE						
Rissoella sp. (unidentifiable)			1		int.	off Isla Ventana
Rissoella bifasciata (Carpenter, 1856)	Bartsch, 1920: 162; pl. 12, f. 2. Keen, 1968: 416, f. 70.		3		sub.	NW
Risoella excolpa Bartsch, 1920	Bartsch, 1920: 161; pl. 12, f. 3.	2 (1)	1		3-7	NW & off Isla Ventana
Rissoella tumens (Carpenter, 1856)	Bartsch, 1920: 160; pl. 12, f. 1. Keen, 1968: 418; f. 71.	1 (1)			7	SE
CAECIDAE						
Caecum sp. (unidentified)		1 (1)		151 (10)	2-13	edges
Micranellum sp. (unidentified)				115 (5)	5-9	edges
Micranellum cf. *M. lobri* Strong & Hertlein, 1939	Strong & Hertlein, 1939: 225; pl. 20, f. 12, 13.	22 (3)	4		7-16	SE, NW
Elephantanellum sp. (unidentified)				1 (1)	3	S
Elephantanellum heptagonum (Carpenter, 1856)	Strong & Hertlein, 1939: 226; pl. 20, f. 9. Keen, 1968: 419, f. 83a, b.		1		3	off Isla Ventana
Elephantulum cf. *E. liratocinctum* (Carpenter, 1856)	Keen, 1968: 419, f. 84a, b.	9 (3)	1	60 (7)	3-17	edges
Fartulum cf. *F. laeve* (C. B. Adams, 1852)	Turner 1956: 60; pl. 17, f. 5.	2 (2)		14 (3)	6-21	S
MODULIDAE						
Modulus cerodes (A. Adams, 1851)	Keen, 1958: 295, f. 196.			2 (1)	6	NE
CERITHIIDAE						
Cerithium sculptum Sowerby, 1855, *anctt.*	Keen, 1958: 303, f. 214.			1 (1)	4	SE

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CERITHIOPSIDAE						
Cerithiopsis sp. (unidentified)				2 (2)	4-6	—
Cerithiopsis cassi Baker, Hanna, & Strong, 1938	Baker, Hanna, & Strong, 1938: 220; pl. 19, f. 5.		1		3	off Isla Ventana
Cerithiopsis cf. *C. curtata* Bartsch, 1911	Bartsch, 1911c: 352; pl. 36, f. 3.		1		3	off Isla Ventana
Cerithiopsis subgloriosa Baker, Hanna, & Strong, 1938	Baker, Hanna, & Strong, 1938: 218; pl. 18, f. 7.		1		3	off Isla Ventana
Cerithiopsis tuberculoides Carpenter, 1856	Bartsch, 1911c: 336; pl. 37, f. 7. Keen, 1968: 423, f. 102a, b.		1		3	off Isla Ventana
Seila assimilata (C. B. Adams, 1852)	Baker, Hanna, & Strong, 1938: 223; pl. 18, f. 5. Turner, 1956: 32; pl. 9, f. 1.			1 (1)	6	NE
Triphora sp. (unidentified)		1 (1)		2 (1)	6-7	—
Triphora chamberlini Baker, 1926	Baker, 1926: 235; pl. 24, f. 2.		1		3	off Isla Ventana
Triphora contrerasi Baker, 1926	Baker, 1926: 230; pl. 24, f. 7.		4		3	off Isla Ventana
Triphora cf. *T. hannai* Baker, 1926	Baker, 1926: 225; pl. 24, f. 1.		2		3	off Isla Ventana
Triphora oweni Baker, 1926	Baker, 1926: 232; pl. 24, f. 10.		1		3	off Isla Ventana
Alaba jeannettae Bartsch, 1910	Bartsch, 1910: 155, f. 3, 4.	4 (1)	9	1 (1)	6-9	NW
Alabina excurvata (Carpenter, 1856)	Keen, 1968: 424, f. 111.	111 (12)	16	32 (8)	2-19	S
CALYPTRAEIDAE						
Crepidula arenata (Broderip, 1834)	Keen, 1958: 313, f. 240.	1 (1)	3		sub.-9	NW

NATICIDAE						
Polinices sp. (unidentifiable)		3 (2)	2	1 (1)	12-40	—
Polinices cf. *P. intemeratus* (Philippi, 1853)	Keen, 1958: 322, f. 269.			3 (3)	6-38	NW, NE
Polinices uber (Valenciennes, 1832)	Keen, 1958: 323, f. 272.			1 (1)	6	NE
Polinices reclusianus (Deshayes, 1839)	Keen, 1958: 324, f. 274.			1 (1)	9	SE
ERATOIDAE						
Erato columbella Menke, 1847	Keen, 1958: 331, f. 289.			2 (2)	4-6	E
STROMBIDAE						
Strombus granulatus Swainson, 1822	Keen, 1958: 336, f. 309.			1 (1)	4	SW
CYMATIIDAE						
"*Cymatium amictum* (Reeve, 1844)," *auctt.*	Keen, 1958: 344, f. 319.	2 (2)			25-36	SC
MURICIDAE						
Trophon sp. (unidentifiable juvs.)			3		3	—
Trophon cf. *T. bristolae* Hertlein & Strong, 1951	Keen, 1958: 364, f. 373.	1 (1)			25	S
COLUMBELLIDAE						
Anachis sp. (unidentifiable)				1 (1)	6	—
Anachis coronata (Sowerby, 1832)	Keen, 1958: 380, f. 424.	1 (1)		1 (1)	6-9	NE
Cosmioconcha palmeri (Dall, 1913)	Keen, 1958: 387, f. 470.		3	4 (1)	sub.-6	NE
Mitrella granti Lowe, 1935	Keen, 1958: 389, f. 480.		1		int.	—
Mitrella lalage Pilsbry & Lowe, 1932	Keen, 1958: 389, f. 482.			2 (2)	4-9	W
Pyrene major (Sowerby, 1832)	Keen, 1958: 392, f. 501.		1		int.	W
Strombina maculosa (Sowerby, 1832)	Keen, 1958: 394, f. 515.			2 (1)	6	NW

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BUCCINIDAE						
Phos minusculus Dall, 1917	Keen, 1958: 406, f. 564.			1 (1)	22	S
NASARIIDAE						
Nassarius angulicostis (Pilsbry & Lowe, 1932)	Keen 1958: 408, f. 568.			1 (1)	6	NW
Nassarius guaymasensis (Pilsbry & Lowe, 1932)	Keen, 1958: 410, f. 577.	1 (1)			36	C
Nassarius tiarula (Kiener, 1841)	Keen, 1958: 413, f. 595.	82 (12)	31	194 (18)	int.-37 (int.-15)	SE
FUSINIDAE						
Fusinus ambustus (Gould, 1853)	Keen, 1958: 418, f. 612. Johnson, 1964: 39.		1		3	off Isla Ventana
OLIVIDAE						
Oliva spicata (Röding, 1798)	Keen, 1958: 421, f. 625.	1 (1)			16	SE
Olivella dama (Wood, 1828)	Keen, 1958: 424, f. 634.			1 (1)	4	W
Olivella fletcherae Berry, 1958	Keen, 1958: 424, f. 634a.	11 (11)		10 (10)	6-45	s
VOLUTIDAE						
Lyria cumingii (Broderip, 1832)	Keen, 1958: 432, f. 666.		1		3	off Isla Ventana
MARGINELLIDAE						
Volvarina taeniolata Mörch, 1860	Coan & Roth, 1966: 287; pl. 50, f. 49-55 Keen, 1966b: 28, f. 34.		3	1 (1)	3-6	NE & off Isla Ventana
Kogomea polita (Carpenter, 1857)	Coan & Roth, 1966: 293, f. 3; pl. 51, f. 75. Keen, 1968: 427, f. 120a-c.		1		3	off Isla Ventana

Cypraeolina margaritula (Carpenter, 1857)	Coan & Roth, 1966: 294, f. 4; pl. 51, f. 77. Keen, 1968: 427, f. 119.	6 (4)	12	12 (3)	sub.-15	s
TURRIDAE						
Daphnella bartschi Dall, 1919	Keen, 1958: 445, f. 717.		1		3	off Isla Ventana
Clavus aeginus (Dall, 1919)	Keen, 1958: 450, f. 746.	1 (1)			17	S
Crassispira sp. (unidentifiable)				1 (1)	9	—
Crassispira rudis (Sowerby, 1834)	Keen, 1958: 462, f. 827.		1		int.	—
Mangelia spp. (unidentified)				4 (3)	9-19	—
Mangelia cyrene Dall, 1919	Keen, 1958: 470, f. 870.	31 (18)	1	16 (12)	9-44 (20-40)	SC
Mangelia cf. *M. danae* Dall, 1919	Dall, 1919a: 63; pl. 21, f. 6.			1 (1)	4	SE
Mangelia trichodes (Dall, 1919)	Dall, 1919a: 62; pl. 19, f. 3.			3 (2)	6-18	NE
Tenaturris nereis (Pilsbry & Lowe, 1932)	Keen, 1958: 474, f. 894.		1		int.	—
Tenaturris pyrrhula (Dall, 1919)	Keen, 1958: 474, f. 895.			15 (1)	13	S
BULLIDAE						
Bulla gouldiana Pilsbry, 1895	Keen, 1958: 496, f. 982.	3 (2)			7-17	W
Bulla punctulata A. Adams in Sowerby, 1850	Keen, 1958: 496, f. 983.	7 (3)		9 (6)	2-12	edges
AKERIDAE						
Haminoea angelensis Baker & Hanna, 1927	Keen, 1958: 496, f. 984.	8 (1)	5		sub.-7	N edges
SCAPHANDRIDAE						
Atys chimera Baker & Hanna, 1927	Keen, 1958: 497, f. 988.		3		9-17	off Isla Ventana

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ACTEONIDAE						
Acteon traskii Stearns, 1897	Keen, 1958: 498, f. 990.	1 (1)			17	W
ACTEOCINIDAE						
Acteocina angustior Baker & Hanna, 1927	Keen, 1958: 499, f. 992.	18 (11)	14	41 (14)	6-31 (6-20)	S, NW
Acteocina carinata (Carpenter, 1856)	Keen 1958: 499. Keen, 1968: 429, f. 128.	374 (49)	13	58 (34)	2-45 (2-30)	S, NW
Acteocina infrequens (C. B. Adams, 1852)	Keen, 1958: 499, f. 995.	31 (10)		19 (8)	2-30	S, NW
Cylichnella gonzagensis (Baker & Hanna, 1927)	Baker & Hanna, 1927: 131; pl. 4, f. 8.	9 (7)			20-31	C
Sulcoretusa paziana (Dall, 1919)	Dall, 1919b: 297. Baker & Hanna, 1927: 132; pl. 4, f. 7.	2 (2)			22-34	W
Volvulella lowei Strong & Hertlein, 1937	Strong & Hertlein, 1937: 164; pl. 35, f. 2. Strong & Hertlein, 1939: 190; pl. 18, f. 1.	17 (14)		3 (3)	7-40	C
PYRAMIDELLIDAE						
Odostomia (Evalea) tenuis Carpenter, 1856	Dall & Bartsch, 1909: 197; pl. 22, f. 3. Keen, 1968: 430, f. 143.	5 (3)			17-21	S
Odostomia (Miralda) planicosta Baker, Hanna, & Strong, 1928	Baker, Hanna, & Strong, 1928: 237; pl. 12, f. 14.		3		3	off Isla Ventana
Odostomia (Todella) dotella Dall & Bartsch, 1909	Dall & Bartsch, 1909: 230; pl. 30, f. 5.	16 (15)			16-46	s
Turbonilla spp. (unidentified)		1 (1)		18 (12)	6-31	—
Turbonilla (Bartschella) sedillina Dall & Bartsch, 1909	Dall & Bartsch, 1909: 121; pl. 12, f. 3, 3a.	1 (1)			17	S
Turbonilla (Chemnitzia) sp. (unidentified)		1 (1)			19	SW

Turbonilla (*Pyrgiscus*) sp. A. (unidentified)		3 (2)		31-36	C
Turbonilla (*Pyrgiscus*) sp. B (unidentified)		3 (3)		16-30	S
Turbonilla (*Pyrgiscus*) *cf. T.* (*P.*) *cortezi* Barstch, 1917	Bartsch, 1917a: 656; pl. 42, f. 7; pl. 45, f. 7.	5 (4)		13-31	S
Turbonilla (*Pyrgiscus*) *macbridei* Dall & Bartsch, 1909	Dall & Bartsch, 1909: 90; pl. 8, f. 13, 13a.	3 (3)		15-36	S, C
Turbonilla (*Pyrgiscus*) *mariana* Bartsch, 1917	Bartsch, 1917a: 654; pl. 45, f. 9.	1 (1)		30	NW
Turbonilla (?*Pyrgiscus*) cf. *T.* (*P.*) *superba* Dall & Bartsch, 1909	Dall & Bartsch, 1909: 80; pl. 7, f. 10, 10a.	1 (1)		25	NW
Turbonilla (*Strioturbonilla*) sp. A (unidentified)		1 (1)		38	NW
Turbonilla (*Strioturbonilla*) sp. B (unidentified)			1	9-32	NW
Turbonilla (*Strioturbonilla*) cf. *T.* (S.) *mexicana* Dall & Bartsch, 1909	Dall & Bartsch, 1909: 45; pl. 3, f. 5, 5a.	3 (3)	2	9-38	C
Turbonilla (*Strioturbonilla*) *nicholsi* Dall & Bartsch, 1909	Dall & Bartsch, 1909: 46; pl. 3, f. 2.	1 (1)		42	NE
Turbonilla (*Ugartea*) *juani* Bartsch, 1917	Bartsch, 1917a: 662; pl. 43, f. 5.	1 (1)		38	C
CAVOLINIDAE					
Cavolina cf. *C. longirostris* (Lesueur, 1821)	Warmke & Abbott, 1961: 152, f. 22v.	1 (1)		30, but probably from pelagic zone	
ELLOBIIDAE					
Melampus sp.		1 (1)		11, but probably drift from intertidal zone	
various unidentifiable gastropods (counted as 1 species in numerical analyses)		4 (4)	1	—	—

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			AMPHINEURA			
ACANTHOCHITONIDAE						
Acanthochitona exquisita (Pilsbry, 1893)	Keen, 1958: 519, f. 9.		1		int.	W

ACKNOWLEDGMENTS

Dr. Myra Keen of Stanford University is responsible for the identifications of nearly all of the molluscan species discussed in this report and for the preliminary organization of the data. She also offered suggestions and criticized the manuscript. Dr. James Rohlf of the University of Iowa demonstrated the use of a computer in data analysis. Dr. Joseph Connell of the University of California at Santa Barbara made many valuable suggestions. Dr. J. Laurens Barnard of the United States National Museum did the field work during his association with the Beaudette Foundation, with support from the National Science Foundation Grant 20909.

Mr. Barry Roth of San Francisco State College aided in sorting the collection; Dr. Judith Terry, then a student at Stanford, helped in the compilation of data; Mrs. Berenice E. Coan typed lists of data and portions of the manuscript and catalogued most of the collection.

LITERATURE CITED

BAKER, F.
1926. Mollusca of the family Triphoridae. (Expedition of the California Academy of Sciences to the Gulf of California in 1921 — VI). Calif. Acad. Sci., Proc. (4) 15: 223-239.

BAKER, F., and G D. HANNA
1927. Marine Mollusca of the order Opisthobranchiata. (Expedition of the California Academy of Sciences to the Gulf of California in 1921 — V). Calif. Acad. Sci., Proc. (4) 16: 123-135.

BAKER, F., G D. HANNA, and A. M. STRONG
1928. Some Pyramidellidae from the Gulf of California. Calif. Acad. Sci., Proc. (4) 17: 205-246.
1930. Some rissoid Mollusca from the Gulf of California. Calif. Acad. Sci., Proc. (4) 19: 23-40.
1938. Some Mollusca of the families Cerithiopsidae, Cerithiidae and Cyclostrematidae from the Gulf of California and adjacent waters. Calif. Acad. Sci., Proc. (4) 23: 217-244.

BARNARD, J. L., and J. R. GRADY
1968. A biological survey of Bahia de los Angeles, Gulf of California, Mexico. I. General Account. San Diego Soc. Nat. Hist., Trans. 15 (6): 51-66.

BARTSCH, P.
1910. The West American mollusks of the genus *Alaba*. U. S. Nat. Mus., Proc. 39: 153-156.
1911a. Descriptions of new mollusks of the family Vitrinellidae from the west coast of America. U. S. Nat. Mus., Proc. 39: 229-234.
1911b. The Recent and fossil mollusks of the genus *Alabina* from the west coast of America. U. S. Nat. Mus., Proc. 39: 409-418.
1911c. The Recent and fossil mollusks of the genus *Cerithiopsis* from the west coast of America. U. S. Nat. Mus., Proc. 40: 327-367.
1911d. The Recent and fossil mollusks of the genus *Alvania* from the west coast of America. U. S. Nat. Mus., Proc. 41: 333-362.
1915. The Recent and fossil mollusks of the genus *Rissoina* from the west coast of America. U. S. Nat. Mus., Proc. 49: 33-62.
1917a. Descriptions of new West American marine mollusks and notes on previously described forms. U. S. Nat. Mus., Proc. 52: 637-681.
1917b. A monograph of West American melanellid mollusks. U. S. Nat. Mus., Proc. 53: 295-356.
1920. The West American mollusks of the families Rissoellidae and Synceratidae, and the rissoid genus *Barleeia*. U. S. Nat. Mus., Proc. 58: 159-176.

CARPENTER, P. P.
1857. Catalogue of the collection of Mazatlan shells in the British Museum collected by Frederick Reigen. London (Brit. Mus.). 552 p.

COAN, E. V.
1964. Biometrical analysis of Mollusca, Bahía de los Angeles, Baja California. [abstract]. Amer. Malacol. Union Rept. for 1964 (Bull. 31): 48.

COAN, E. V. and B. ROTH
1966. The West American Marginellidae. Veliger 8: 276-299.

DALL, W. H.
1919a. Descriptions of new species of mollusks of the family Turridae from the west coast of America and adjacent regions. U. S. Nat. Mus., Proc. 56: 1-86.
1919b. Descriptions of new species of Mollusca from the North Pacific Ocean in the collection of the United States National Museum. U. S. Nat. Mus., Proc. 56: 293-371.

DALL, W. H, and P. BARTSCH
1909. A monograph of West American pyramidellid mollusks. U. S. Nat. Mus., Bull. 68: i-xxi + 1-258.

Hertlein, L. G., and A. M. Strong
1951. Mollusks from the west coast of Mexico and Central America. Part X (Eastern Pacific Expeditions of the New York Zoological Society — LXIII). Zoologica 36: 67-120.

Johnson, R. I.
1964. The Recent Mollusca of Augustus Addison Gould. U. S. Nat. Mus., Bull. 239: 1-182.

Keen, A. M.
1958. Sea shells of tropical West America. Stanford, Calif. (Stanford Univ.). 619 p.
1964. A quantitative analysis of molluscan collections from Isla Espiritu Santo, Baja California, Mexico. Calif. Acad. Sci., Proc. (4) 30: 175-206.
1966a. West American mollusk types in the British Museum (Natural History) II. Species described by R. B. Hinds. Veliger 8: 265-275.
1966b. Moerch's west Central American molluscan types with proposal of a new name for a species of *Semele*. Calif. Acad. Sci., Occ. Papers no. 59: 1-33.
1966c. West American mollusk types at the British Museum (Natural History) III. Alcide d'Orbigny's South American collection. Veliger 9: 1-7.
1968. West American mollusk types at the British Museum (Natural History) IV. Carpenter's Mazatlan Collection. Veliger 10: 389-439.

McLean, J. H.
1961. Marine mollusks from Los Angeles Bay, Gulf of California. San Diego Soc. Nat. Hist., Trans. 12: 449-476.

Olsson, A. A.
1961. Mollusks of the tropical Eastern Pacific, particularly from the southern half of the Panamic-Pacific faunal province (Panama to Peru). Ithaca, New York (Paleo. Res. Inst.). 574 p.

Palmer, K. v. W.
1958. Type specimens of marine Mollusca described by P. P. Carpenter from the West Coast (San Diego to British Columbia). Geol. Soc. Amer., Mem. 76: 1-376.
1963. Type specimens of marine Mollusca described by P. P. Carpenter from the west coast of Mexico and Panama. Bull. Amer. Paleont. 46: 285-408.

Parker, R. H.
1960. Ecology and distributional patterns of marine macro-invertebrates, northern Gulf of Mexico. Recent Sediments, Northwest Gulf of Mexico, 1951-1958. Tulsa, Oklahoma (Amer. Ass. Pet. Geol.) pp. 302-381.
1964a. Zoogeography and ecology of some macro-invertebrates, particularly mollusks, in the Gulf of California and the continental slope off Mexico. Vidensk. Medd. fra Dansk Naturhist. Foren. 126: 1-178.
1964b. Zoogeography and ecology of macro-invertebrates of the Gulf of California and continental slope of western Mexico. Amer. Ass. Pet. Geol., Mem. 3: 331-376.

Pilsbry, H. A., and A. A. Olsson
1945. Vitrinellidae and similar gastropods of the Panamic Province. Part I. Acad. Nat. Sci. Philadelphia, Proc. 97: 249-278.
1952. Vitrinellidae of the Panamic Province. Part II. Acad. Nat. Sci. Phidelaphia, Proc. 104: 35-88.

Reish, D. J.
1968. A biological survey of Bahia de los Angeles, Gulf of California, Mexico. II. Benthic Polychaetous Annelids. San Diego Soc. Nat. Hist., Trans. 15 (7): 67-106.

Strong, A. M., and L. G. Hertlein
1937. New species of Recent mollusks from the coast of western North America. (The Templeton Crocker Expedition of the California Acad. Sci., 1932. — No. 25). Calif. Acad. Sci., Proc. (4) 22: 159-178.
1939. Marine mollusks from Panama collected by the Alan Hancock Expedition to the Galapagos Islands, 1931-1932. Alan Hancock Pacific Exped. 2: 177-245.

Thorson G.
1957. Bottom communities (sublittoral or shallow shelf). Geol. Soc. Amer., Mem. 67, 1: 461-534.

Turner, R. D.
1956. The Eastern Pacific marine Mollusca described by C. B. Adams. Mus. Comp. Zool., Harvard Univ., Occ. Papers on Mollusks 2: 21-136.

Warmke, G. L., and R. T. Abbott
1961. Caribbean seashells: a guide to the marine mollusks of Puerto Rico and other West Indian islands, Bermuda and the lower Florida Keys. Narberth, Pennsylvania (Livingston Publ.). 346 p.

Accepted for Publication 18 March 1968

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TYPE SPECIMENS OF BIRDS IN THE SAN DIEGO NATURAL HISTORY MUSEUM

JOSEPH R. JEHL, JR.

TRANSACTIONS

OF THE SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. 15, NO. 9, 25 SEPTEMBER 1968

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The bird collections of the San Diego Society of Natural History are mainly composed of specimens from the southwestern United States and Baja California, Mexico. Among the more than 37,000 specimens are 17 holotype and 2 syntype specimens that served as the bases for 18 avian subspecies. Twelve of these subspecies were proposed by the late Laurence M. Huey, Curator of Birds and Mammals at the San Diego Natural History Museum from 1923 to 1961, four by the late A. J. van Rossem, one by the late Frank Stephens, and one by J. Elton Green and Lee W. Arnold. Of the 18 forms proposed, ten are currently considered valid by most workers.

In this list of specimens the following information is given: name as originally published; name currently accepted by the A. O. U. Check-list, 5th ed. or, where pertinent, by the Check-list of the birds of Mexico, if different from the original; and type locality. Geographic coordinates not given in the original descriptions, emendations, and corrected spellings are given in brackets. The current taxonomic status of each race has been reviewed. For brevity I have usually cited only the earliest published opinion on the validity of each race, except that major revisionary studies are also cited. Unless stated otherwise, races accepted by the first reviewer are recognized in each of the publications cited below that appeared subsequent to the original description; conversely, races considered invalid by the first reviewer have been merged by all subsequent authors.

American Ornithologists' Union
1957. Check-list of North American birds, 5th ed.

Friedmann, H. L., L. Griscom, and R. T. Moore
1950. Distributional check-list of the Birds of Mexico, Pt. 1. Pac. Coast Avifauna 29.

Miller, A. H., H. L. Friedmann, L. Griscom, and R. T. Moore
1957. Distributional check-list of the birds of Mexico, Pt. 2. Pac. Coast Avifauna 33.

Peters, J. L., and others
1931-1962. Check-list of birds of the world. Vols. 1-7, 9, 15. Harvard University Press.

Cory, C. B., C. E. Hellmayr, and B. Conover
1918-1949. Catalogue of birds of the Americas and adjacent islands. Pt. 1, nos. 1-4; Pt. 2, nos. 1-2; Pts. 3-11. Field Mus. Nat. Hist. Zool. Ser. Vol. 13.

To determine the validity of a taxon, it is often necessary to reconstruct the type-series and to independently analyze the material upon which a description is based. For

this reason paratypes are listed whenever possible, even though they have no nomenclatorial standing. No specimens formally designated as paratypes are known to be in the collections. However, following Cochran (1961. U. S. Natl. Mus. Bull. 220: xii) I consider paratypes to include all specimens that served as the basis for the original description regardless of whether they were formally designated.

Huey often listed catalog numbers of specimens that he referred to new taxa; such specimens I consider unquestioned paratypes. In some instances, he gave only locality data for referred specimens, but from these data and the dates of collection it is possible to identify those specimens still extant in this collection. Each series of paratypes thus identified is indicated by an asterisk. Because of the greater risk of error, I made no attempt to identify specimens borrowed from other institutions. Stephens, Green and Arnold, and van Rossem gave no references to specimens they examined.

Catalogue

Hydranassa tricolor occidentalis Huey

San Diego Soc. Nat. Hist., Trans. 5 (7): 83-84; 10 October 1927.

= *Hydranassa tricolor ruficollis* (Gosse)

Holotype. — Adult male; skin in good condition. Collected by L. M. Huey, 25 May 1926. Original no. 54, now SDSNH no. 10644.

Type locality. — Scammon['s] Lagoon, Baja California, Mexico; lat. 28°04′N, long. 114°05′W.

Paratypes.* — 9788, Sweetwater slough, San Diego Bay, California; 30889, La Punta, San Diego Bay, California; 11414-11416, 11435, 11462, 30890, Pond Lagoon, Baja California, Mexico; 10643, 10645-10647, Scammon's Lagoon, Baja California, Mexico; 11463, San Ignacio Lagoon, Baja California, Mexico.

Status. — Grinnell (1928. Univ. Calif. Publ. Zool. 32: 84) did not recognize this race, presumably on the basis of a letter from van Rossem stating "material examined in eastern museums shows great range of variation in birds of the South Atlantic portion of North America, quite including the extremes in size recorded by Huey from Lower California. Neither does there appear to be even an average color difference." Peters (1931, Check-list of birds of the World, Vol. 1, p. 113) placed *occidentalis* in synonomy with *ruficollis*. The A. O. U. Check-list (1931, 4th ed., p. 29) noted only that Huey had proposed racial separation for the birds from Baja California. Apparently the validity of this race has never been satisfactorily determined.

Nyctanassa violacea bancrofti Huey

Condor 29: 167-168, fig. 56; 15 May 1927.

Holotype. — Adult male: skin in good condition. Collected by L. M. Huey, 25 May 1926. Original no. 64, now SDSNH no. 10654.

Type locality. — Scammon['s] Lagoon, Baja California, Mexico; lat. 28°04′N, long. 114°05′W.

Paratypes.* — 10655-10657, Scammon's Lagoon, Baja California, Mexico; 2468, San Benito Is., Mexico.

Status. — Recognized as a valid subspecies by the A. O. U. Check-list Committee (1931. Check-list of North American Birds, 4th ed., p. 31).

Callipepla gambeli deserticola Stephens

Auk 12: 371-372; October 1895

= *Lophortyx gambelii gambelii* Gambel

Syntypes. — Adult male; skin in good condition. Collected by F. M. Stephens, 15 January 1890. Original no. 4969, now SDSNH no. 264. (Stephens incorrectly cited this specimen as a female, but male sex is indicated by the original label as well as by plumage.) Adult female; skin in good condition. Collected by F. M. Stephens, 1 January 1890. Original no. 4938, now SDSNH no. 265.

Type locality. — The male specimen (SDSNH no. 264) was collected at Palm Springs, San Diego County [now Riverside County], California, elev. 100 ft. The female (SDSNH no. 265) was taken at Walters (now Mecca), Colorado desert [now Riverside County], California, elev. 250 ft. Since the male was listed first by Stephens, Grinnell (1931, Univ. Calif. Publ. Zool. 38: 270) restricted the type locality to Palm Springs. Because of this action, the male specimen must be considered a lectotype.

Status. — Considered inseparable from *Callipepla gambelii* by the A. O. U. Check-list Committee (1897. Auk 14: 132).

Oreortyx picta eremophilus van Rossem

Condor 39: 22; 15 January 1937.

Holotype. — Adult male; skin in good condition. Collected by A. J. van Rossem, 27 October 1935. SDSNH no. 17324.

Type locality. — Lang Spring, Mountain Spring Canyon, Argus Mountains, Inyo County, California, elev. 6000 ft.

Status. — Recognized by the A. O. U. Check-list Committee (1944. Auk 61: 446). Hellmayr and Conover (1948. Cat. birds of the Americas, Vol. 13, Pt. 1, No. 2, p. 229) merged *eremophilus* with *picta.*

Endomychura hypoleuca scrippsi Green and Arnold

Condor 41: 25-29, figs. 14-16; 17 January 1939.

Holotype. — Adult male; skin in good condition. Collected by J. E. Green, 16 May 1938. Original no. 4105, now SDSNH no. 17934.

Type locality. — Anacapa Island, California.

Staus. — Recognized by the A. O. U. Check-list Committee (1944. Auk. 61: 449).

Otus asio cardonensis Huey

Auk 43: 360-362; July 1926.

Holotype. — Adult female; skin in good condition. Collected by L. M. Huey 18 April 1923. SDSNH no. 8671.

Type locality. — Canyon San Juan de Dios (10 mi E El Rosario), Baja California, Mexico [lat. 30°11′N, long. 115°35′W].

Paratypes. — 8607, 8610-8616, 6 mi E El Rosario, Baja California, Mexico; 8671, 10 mi E El Rosario, Baja California, Mexico.

Status. — Recognized by the A. O. U. Check-list Committee (1944. Auk 61: 450). and by Marshall (1967. West. Found. Vert. Zool. Monograph 1, p. 13).

Dryobates villosus scrippsae Huey

San Diego Soc. Nat. Hist., Trans. 5(1): 9; 20 February 1927.

= *Dendrocopos villosus hyloscopus* (Cabanis and Heine)

Holotype. — Adult male; skin in good condition. Collected by L. M. Huey, 27 September 1926. SDSNH no. 10847.
Type locality. — La Grulla, Sierra San Pedro Mártir, Baja California, Mexico [lat. 30°53′N, long. 115°26′W], elev. 7500 ft.
Paratypes.* — In his original description, Huey (*op. cit.*) referred 10 specimens from Sierra San Pedro Mártir to this race. Ten specimens in this collection are doubtless the birds examined by Huey: 8761, 8762, 8786, 8814, 8815, 8842, 10829, 10848, 10853, 10854. Huey also referred 20 specimens from the Sierra Juárez region to *scrippsae*. It is virtually certain that these included the following 14 specimens: 9441, 9497, 9486, 9511, 9524, 9539, 10881, 10882, 10960, 11003, 11019, 11024, 11063, 11077.
Status. — Todd (1946. Ann. Carnegie Mus. 30: 512) considered *D. v. scrippsae* a synonym of *D. v. hyloscopus*.

Dryobates nuttallii longirostrata Huey

San Diego Soc. Nat. Hist., Trans. 5(2): 27: 14 July 1927.
= *Dendrocopos scalaris eremicus* (Oberholser)

Holotype. — Adult male; skin in good condition. Collected by L. M. Huey, 13 April 1926. SDSNH no. 10448.
Type locality. — San Felipe, Baja California, Mexico [lat. 31°02′N, long. 114°15′W].
Paratype. — 31776, San Felipe, Baja California, Mexico.
Status. — As Grinnell (1928. Univ. Calif. Publ. Zool. 32: 121) pointed out, this form of "Nuttall's Woodpecker" was based on misidentified specimens of Ladder-backed Woodpecker (*Dendrocopos scalaris*).

Aphelocoma californica cactophila Huey

San Diego Soc. Nat. Hist., Trans. 9(35): 432, 434; 1 October 1942.
= *Aphelocoma coerulescens cactophila* Huey

Holotype. — Adult female; skin in good condition. Collected by L. M. Huey, 24 October 1930. SDSNH no. 13549.
Type locality. — 3 mi N Punta Prieta, Baja California, Mexico; lat. 28°56′N, long. 144°12′W.
Paratypes.* — 32230, 12041, 5 mi N Santa Rosalía Bay, Baja California, Mexico; 32229, 12,000, Mesquital, Baja California, Mexico; 11929-11932, 32225-32228, Llano de San Bruno, Baja California, Mexico; 11988, 32224 10 mi El Cañon, Baja California, Mexico; 13480, 13552, 13553, 14068, 14070, 25 mi N Punta Prieta, Baja California, Mexico; 11782, 9 mi N Punta Prieta, Baja California, Mexico; 13816, 14069, 3 mi N Punta Prieta, Baja California, Mexico; 11944, Campo Los Angeles, Baja California, Mexico; 15242, 15243, Santa Teresa Bay, Baja California, Mexico; 18275, San Borjas Mission, Baja California, Mexico.
Status. — Recognized as a valid race by the A. O. U. Check-list Committee (1945. Auk 62: 445) and by Pitelka (1951. Univ. Calif. Publ. Zool. 50 (3): 239-243). Blake (*in* Peters, 1962. Vol. 15, p. 212) considered *cactophila* a synonym of *hypoleuca*.

Auriparus flaviceps ignatius Huey

San Diego Soc. Nat. Hist., Trans. 6(13): 211-212; 30 September 1930.
= *Auriparus flaviceps flaviceps* (Sundervall)

Holotype. — Adult male; skin in good condition. Collected by L. M. Huey, 8 March 1928. SDSNH no. 11886.

Type locality. — San Ignacio, Baja California, Mexico; lat. 27°17′N, [long. 112°55′W].

Paratypes.* — Huey referred 23 specimens to *ignatius*, which doubtless included the following 18 in this collection: 15331, 15332, San Lucas, Baja California, Mexico; 32404, 32405, 10252, San José del Cabo, Baja California, Mexico; 32400, Calmallí, Baja California, Mexico; 12010, 12016, 32401, Mesquital, Baja California, Mexico; 11873, 11881, 24248, 24249, 32403, San Ignacio, Baja California, Mexico; 15335-15338, Santa Teresa Bay, Baja California, Mexico.

Status. — Grinnell (1931. Condor 33: 167) considered *A. f. ignatius* a synonym of *A. f. flaviceps*.

Thryomanes bewickii magdalenensis Huey

San Diego Soc. Nat. Hist., Trans. 9(35): 430-431; 1 October 1942.

Holotype. — Adult male; skin in good condition. Collected by L. M. Huey, 20 November 1941. SDSNH no. 18453.

Type locality. — Santo Domingo, Magdalena Plain, Baja California, Mexico; lat. 25°30′N, [long. 111°55′W].

Paratypes. — 18435, 18438, 18440-18444, 18452, 18456, Santo Domingo, Baja California, Mexico; 18410, Arroyo Seco, Baja California, Mexico.

Status. — Recognized by the A. O. U. Check-list Committee (1948. Auk 65: 441).

Thryomanes bewickii atricauda Huey

San Diego Soc. Nat. Hist., Trans. 9(35) 429, 431: 1 October 1942.

= *Thryomanes bewickii cerroensis* (Anthony)

Holotype. — Adult male; skin in good condition. Collected by L. M. Huey, 13 October 1941. SDSNH no. 19283.

Type locality. — San Borjas [= Borja], Baja California, Mexico; lat. 28°52′N, long. 113°53′W.

Paratypes. — 13817, 13556, 13861, 13862, 25 mi N Punta Prieta, Baja California, Mexico; 11786, Punta Prieta, Baja California, Mexico; 18272, 18282, San Borjas Mission, Baja California, Mexico.

Status. — I find no evidence that the validity of this form was reviewed by the A. O. U. Check-list Committee. Miller, Friedmann, Griscom, and Moore (1957. Pacific Coast Avifauna 33: 159) synonomized *T. b. atricauda* with *T. b. cerroensis*, without stated reasons.

Dendroica erithachoroides rhizophorae van Rossem

San Diego Soc. Nat. Hist., Trans. 8(10): 67-68; 24 August 1935.

= *Dendroica petechia rhizophorae* van Rossem

Holotype. — Adult male; skin in good condition. Collected by A. J. van Rossem, 30 April 1930. Original no. 13008; Dickey collection no. 30293; SDSNH no. 17090.

Type locality. — Tobari Bay, Sonora, Mexico; lat. 26°59′N, long. 110°56′W.

Status. — Validity of this race accepted by Miller, Friedmann, Griscom, and Moore (1957. Pacific Coast Avifauna 33: 247).

Remarks. — *Miller* et al. (*op. cit.*) incorrectly stated that this specimen was in the Dickey collection (T. R. Howell, pers. comm.).

Dendroica erithachorides hueyi van Rossem

San Diego Soc. Nat. Hist., Trans. 11(3): 50-51; 25 February 1947.

= *Dendroica petechia castaneiceps* Ridgway

Holotype. — Adult male; skin in good condition. Collected by L. M. Huey, 18 April 1927. SDSNH no. 11471.

Type locality. — San Ignacio Lagoon, Baja California, Mexico [near lat. 26°50′N, long. 113°10′W].

Status. — Considered a synonym of *D. p. castaneiceps* by Miller, Friedmann, Griscom, and Moore (1957. Pacific Coast Avifauna 33: 246).

Richmondena cardinalis seftoni Huey

San Diego Soc. Nat. Hist., Trans. 9(21): 216-217; 31 July 1941.

Type. — Adult male; skin in good condition. Collected by L. M. Huey, 25 April 1940. SDSNH no. 18147.

Type locality. — Santa Gertrudis Mission, Baja California, Mexico [lat. 28°03′N, long. 113°06′W].

Paratypes. — 18135, 18146, Santa Gertrudis Mission, Baja California, Mexico.

Status. — Recognized by the A. O. U. Check-list Committee (1948. Auk 65: 442).

Pipilo fuscus eremophilus van Rossem

San Diego Soc. Nat. Hist., Trans. 8(11): 70-71; 24 August 1935.

Type. — Adult male; skin in good condition. Collected by A. J. van Rossem, 22 May 1935. SDSNH no. 17083.

Type locality. — Lang Spring, Mountain Springs Canyon, Argus Mts., Inyo County, California, elev. 5500 ft.

Status. — Recognized by the A. O. U. Check-list Committee (1944. Auk 61: 461) and by Davis (1951. Univ. Calif. Publ. Zool. 52(1): 103).

Passerculus rostratus anulus Huey

San Diego Soc. Nat. Hist., Trans. 6(10): 204-206; 30 August 1930.

= *Passerculus sandwichensis anulus* Huey

Holotype. — Adult male; skin in good condition. Collected by L. M. Huey, 21 May 1926. SDSNH no. 10523.

Type locality. — South side of entrance to Scammon['s] Lagoon, Baja California, Mexico; lat. 27°54′N, long. 114°18′W.

Status. — Recognized as a valid race by the A. O. U. Check-list Committee (1944. Auk 61: 462) and by Peters and Griscom (1938. Bull. Mus. Comp. Zool. 80: 475).

Amphispiza belli xerophilus Huey

San Diego Soc. Nat. Hist., Trans. 6(16): 229-230; 24 December 1930.

= *Amphispiza belli cinerea* Townsend

Holotype. — Adult female; skin in good condition. Collected by L. M. Huey, 31 October 1930. SDSNH no. 13563.

Type locality. — Santa Catarina Landing, Baja California, Mexico; lat. 29°30′N, long. 115°16′W.

Status. — This form was listed by Hellmayr (1938. Zool. Ser., Field Mus. Nat. Hist., Vol. 13, pt. 11, p. 543) but was apparently ignored by the A. O. U. Check-list Com-

mittee. Miller, Friedmann, Griscom, and Moore (1957. Pacific Coast Avifauna 33: 381) considered *xerophilus* "a synonym, somewhat intermediate toward *A. b. cinerea*."

ACCEPTED FOR PUBLICATION 6 AUGUST 1968

San Diego Natural History Museum, P. O. Box 1390, San Diego, California.

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GEOGRAPHIC VARIATION IN THE CLINGFISH, *GOBIESOX EUGRAMMUS* BRIGGS

DAVID W. GREENFIELD AND JAMES W. WILEY

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GEOGRAPHIC VARIATION IN THE CLINGFISH, *GOBIESOX EUGRAMMUS* BRIGGS

David W. Greenfield and James W. Wiley

Abstract. — The clingfish, *Gobiesox eugrammus* Briggs, is redescribed from new material collected at Punta Banda on the Pacific Coast of Baja California, Mexico and San Diego County, California. The Guadalupe Island population shows some differences from the mainland population but the species is considered monotypic. *G. eugrammus* was found to live near and under the sea urchin *Strongylocentrotus franciscanus*. The range of *Gobiesox maeandricus* is extended to Mexican waters.

Resumen. — Se describe de nuevo *Gobiesox eugrammus* Briggs, basándose en material recogido en Punta Banda, en la costa Pacífica de Baja California, México, y en la región de San Diego, California. Los peces que integran la población que habita la zona de la Isla Guadalupe, presentan algunas diferencias en relación con los que se encuentran a lo largo de las costas continentales. Sin embargo, esta especie se considera monotípica. *Gobiesox eugrammus* vive junto con el erizo de mar *Strongylocentrotus franciscanus*, y debajo de los mismos. La región habitada por *Gobiesox meandricus* se extiende hasta aguas mexicanas.

Gobiesox eugrammus Briggs was originally considered to be endemic to Guadalupe Island. However, recent field work indicates that its range is more extensive. Briggs (1965) first recorded the species from the mainland of Mexico at the south side of Punta Banda. In July 1967, Wiley captured a specimen there at a depth of 30 feet and in September 1967 he captured another individual at the same locality. In October 1967, eleven specimens were collected by the authors, P. A. Adams, D. Hensley, and D. Wildrick at depths of 30 to 90 feet, and in January 1968 the authors collected 15 additional specimens at the same locality. The great number of specimens captured in these latter trips resulted from our discovery that *G. eugrammus* associates with the sea urchin *Strongylocentrotus franciscanus*. Students from the University of California at Los Angeles also collected two clingfish from the south side of Punta Banda in November 1967.

These collections indicate that *G. eugrammus* maintains populations in the Punta Banda region. The discovery of a specimen in the Scripps Institution of Oceanography collections taken at Bird Rock, San Diego County, California, shows that this species occurs at least occasionally as far north as southern California, although its status there is not known.

Since these additional specimens substantially supplement the original description of *G. eugrammus*, and since the mainland population exhibits a statistically significant difference from the Guadalupe population, a complete description is presented. The uniform plan and sequence adopted by Briggs (1955) is followed, as are his methods of taking the counts and measurements, with the exception of the dorsal and anal fin ray counts, which do not include the two extra rays added to the counts by Briggs. Radiographs of 31 specimens from the mainland and eight specimens from Guadalupe Island failed to reveal the two hidden rays mentioned by Briggs. The range of body propor-

tions is presented first, followed by the mean. Proportional measurements were made by arithmetically dividing one measurement into another.

MATERIAL EXAMINED

Mainland population. — United States National Museum USNM 203076 38.0 mm SL, Punta Banda, Mexico, October 14, 1967: USNM 203077 32.8, 41.0, 41.6 mm SL, Punta Banda, Mexico, October, 1967. Scripps Institution of Oceanography SIO59-307-60C 34.4 mm SL, Punta Banda, Mexico, August, 1959: SIO67-209-60C 43.2 mm SL, Bird Rock, San Diego Co., Calif., October, 1967: SIO68-287-60C 20.1, 23.7, 24.2, 24.6, 26.4, 26.6, 27.6, 28.6, 35.0, 36.0, 36.7, 37.8, 42.8, 43.2, 49.0 mm SL, Punta Banda, Mexico, January, 1968. California Academy of Sciences CAS 24139 36.8, 39.3 mm SL, Punta Banda, Mexico, October, 1967. Los Angeles County Museum LACM-30122-1 32.4, 31.5 mm SL, Punta Banda, Mexico, October, 1967. Field Museum Natural History FMNH 74571 29.3, 31.1 mm SL, Punta Banda, Mexico, October, 1967. Stanford University 31.4 mm SL, Punta Banda, Mexico, September, 1976. British Museum (Natural History) 1968•8•1•1 40.8 mm SL, Punta Banda, Mexico, July, 1967. University of California at Los Angeles W67-150 38.6, 43.8 mm SL, Punta Banda, Mexico, November, 1967.

Guadalupe Island population. — Scripps Institution of Oceanography SIO63-174-60A (4) — Guadalupe Island, Mexico, April, 1963; SIO63-167-60A (1) — Guadalupe Island, Mexico, April, 1963; SIO63-184-60A (3) — Guadalupe Island, Mexico, April, 1963; SIOH50-42-60A (4) — paratypes — Guadalupe Island, Mexico, February, 1950; SIOH50-32-60A (2) — Guadalupe Island, Mexico, February, 1950.

Gobiesox eugrammus Briggs

Figure 1, Table 1

Diagnosis. — A *Gobiesox* with poor development of papillae on head. Margin of upper lip smooth. Dorsal origin much closer to upper pectoral base than to caudal base. Position of anus variable, usually closer to anal fin origin than rear margin of disc, but may be closer to rear margin of disc than anal fin origin, or equidistant, under first to second dorsal ray. Eye 3.72 — 5.10: 4.29 in head. Eye in interorbital .89 — 1.42: 1.13. Caudal peduncle depth in eye .92 — 1.40: 1.13. Length of disc 2.67 — 3.86: 3.03, tip of chin to anterior margin of disc 4.77 — 6.95: 5.96, both in standard length. Each part of disc region C consists primarily of 3 longitudinal rows of papillae; there are 7 or 8 rows across width of disc region A. A row of elongate papillae present on membranes between distal half of pelvic rays. In the adult, tip of depressed anal fin extends to or slightly beyond caudal base, as does dorsal. Dorsal rays 11 — 13 (usually 12), anal rays 8 — 10 (usually 10), pectoral rays 21 — 24, caudal rays 12 — 16, and vertebrae 26 — 29 (usually 27).

Description. — Standard length of specimens 12.6 to 49.0 mm. Body depressed; depth 4.66 — 7.50: 5.87 in standard length. Caudal peduncle moderate; least depth 1.02 — 1.73: 1.39 in its length. Head well depressed; length 2.34 — 3.07: 2.72 and width 2.29 — 3.21: 2.69 in standard length. Snout shallow with lateral outline slightly rounded, 3.37 — 5.60: 4.49 in head. Interorbital 3.03 — 4.93: 3.84 in head. Posterior nostril directly above anterior edge of eye; anterior nostril with a bilobed dermal flap extending from its posterior margin. Teeth of lower jaw in two rows, outer row of 3 to 5 pairs of incisors anteriorly, rounded or slightly pointed and larger than inner row. These followed on each side by row of enlarged canines. Teeth of upper jaw conical, irregular in size and position, forming a deep patch, followed on each side by row of

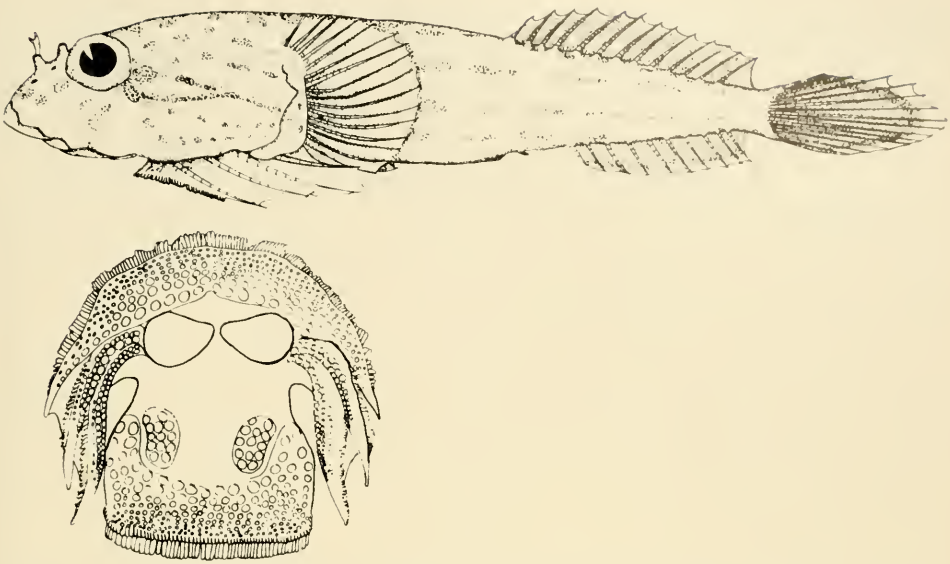

Figure 1. *Gobiesox eugrammus* (USNM 203076), Punta Banda, Mexico. Inset of disc region.

slightly recurved canines.

All papillae on head shallow, lobe-like structures, none on upper lip margin and none on snout above center of premaxillary groove. Upper attachment of gill membrane opposite fourth to sixth (usually fifth) pectoral ray. Subopercular spine well developed but covered by skin of opercle region. Fleshy pad on pectoral base conspicuous, with free posterior margin extending from area of upper gill membrane. Attachment of axial dermal flap opposite fifth to ninth pectoral ray. Dorsal-caudal distance extends forward to point about midway between posterior margin of gill membrane and orbit, 2.26 — 2.90: 2.53 in standard length; postdorsal-caudal distance 2.06 — 3.87: 2.79 in dorsal length. Depressed tip of anal fin extends slightly beyond vertical line from caudal base.

Coloration. — In alcohol, light brown dorsal and lateral sides covered with more or less equally spaced light spots about 1/3 diameter of eye, becoming elongated into bars posteriorly. Darker areas between light spots with numerous small or unpigmented light spots which are visible with magnification. Body crossed by 7 dark vertical bars, fading in intensity with preservation. First bar extends from rictus to point under anterior

TABLE 1

COUNTS OF MAINLAND AND GUADALUPE ISLAND *Gobiesox eugrammus*

	Dorsal Rays			Anal Rays			Pecoral Rays				Principal Caudal Rays					Vertebrae			
	11	12	13	8	9	10	21	22	23	24	12	13	14	15	16	26	27	28	29
Mainland	3	24	5	1	8	22	4	17	7	3	2	7	17	4	1	2	16	10	1
Guadalupe Island	1	6	7			14		1	9	4		9	5			1	4	3	

margin of orbit. Second originates on lower portion of cheek and runs across head directly posteriorly to eyes. Next two bands run between upper margins of pectoral fins, close together; each often appears as a single band. Fifth band widest; extends anteriorly to dorsal origin. Sixth band runs from anal origin to point midway along dorsal base. Last band located between last few fin rays of dorsal and anal fins. Caudal fin dark brown to black. Area between last dark vertical band and caudal fin appears to have light vertical band across it. Vertical fins brownish-black, with transparent tips. Pectorals light with peppering of melanophores on anterior two-thirds; on posterior third of fins rays only peppered, membranes immaculate. Ventral surface of body lighter, with only scattered melanophores.

In life, base color of dorsal and lateral sides of body uniform translucent cream. Ventral parts translucent; abdominal organs visible through skin. Upper parts of body with light-orange markings, round on head, becoming oval in region of operculum and more elongate longitudinally near caudal fin. Dorsal and caudal fins black with white margins. Anal fin grey with white margin. Pectorals and pelvic sucker white. Eye with red outer and yellow inner rings encircling black pupil.

When placed on a dark background, or upon death, the dorsal and lateral trans-

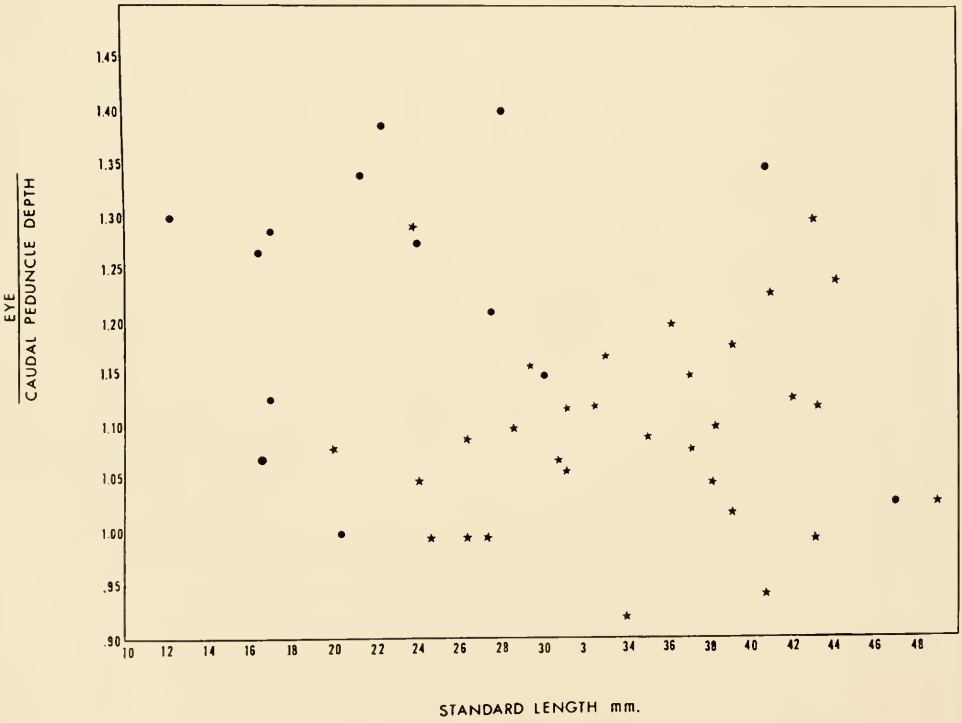

Figure 2. Relationship of greatest depth of caudal peduncle into eye diameter for mainland population (stars) and Guadalupe Island population (circles) of *Gobiesox eugrammus.*

lucent cream areas become generally darkened as melanophores expand. Concentrated melanophores form the 7 dark vertical bars mentioned above. These bars look dark bluish to the naked eye, but appear black under magnification.

COMPARISON OF MAINLAND AND GUADALUPE ISLAND POPULATIONS

Mainland *Gobiesox eugrammus* may be separated from the Guadalupe Island specimens by a difference in the ratio of the caudal-penducle depth into the eye. The Guadalupe population has a mean value of 1.23 with a range of 1.00 — 1.40, while the mainland population has a mean value of 1.09 with a range of .92 — 1.30 (Fig. 2). These differences are statistically significant at the .001 level ($t = 3.929$, 40 d.f.) using the "Student's" t-test. Although not as useful in separating the two populations, there are statistically significant differences in the head width and length, tip of chin to anterior margin of disc, all in standard length, and the width of the orbit in head length (Table 2). Other body proportions yielding statistically significant differences, such as length of the disc and greatest body depth, both in standard length, are a result of

TABLE 2

COMPARISON OF MORPHOMETRICS BETWEEN MAINLAND AND GUADALUPE POPULATIONS OF *G. eugrammus*

BODY PROPORTION	GUADALUPE ISLAND			MAINLAND			t-VAUUE
	Range	Mean	SD	Range	Mean	SD	40 d.f.
Caudal peduncle depth in eye	1.00-1.40	1.23	.13	.92-1.30	1.09	.10	3.929 $p<.001$
Eye in head	3.72-5.10	4.09	.37	3.74-4.95	4.37	.32	2.586 $p<.025$
Length of disc in SL	2.92-3.86	3.25	.28	2.67-3.12	2.93	.13	5.234* $p<.001$
Tip of chin to anterior margin of disc in SL	4.77-6.95	5.56	.58	5.48-6.67	6.14	.40	3.885 $p<.001$
Greatest depth in SL	5.72-7.50	6.33	.52	4.66-6.65	5.66	.41	4.629* $p<.001$
Depth of caudal peduncle in its length	1.06-1.73	1.44	.19	1.02-1.62	1.36	.15	1.171 not sig.
Head length in SL	2.34-2.86	2.63	.14	2.55-3.07	2.76	.12	3.161 $p<.005$
Head width in SL	2.33-3.21	2.84	.25	2.29-2.84	2.62	.13	3.880 $p<.001$
Snout in head	3.37-5.44	4.26	.63	3.40-5.60	4.60	.53	1.873 not sig.
Dorsal caudal length in SL	2.26-2.90	2.57	.17	2.32-2.83	2.51	.12	1.344 not sig.
Postdorsal in dorsal length	2.30-3.28	2.64	.25	206-3.87	2.87	.40	1.971 not sig.
Bony interorbital width in head	3.13-4.27	3.86	.24	3.03-4.93	3.83	.44	0.222 not sig.
Eye in interorbital	.91-1.42	1.08	.13	.89-1.35	1.16	.13	1.856 not sig.

*Significance due to allometric growth

allometric growth. Since the sample from Guadalupe Island is composed mostly of smaller individuals than is the mainland sample (in which allometric growth can be demonstrated) the t-test simply was comparing large with small specimens. There are modal differences in both the number of pectoral rays, 22 for the mainland population and 23 for the Guadalupe Island population, and the number of principal caudal rays, 14 for the mainland population and 13 for the Guadalupe Island population. Since these counts vary inversely, they probably do not result from differences in environmental temperatures in the source areas.

It is possible that the mainland and Guadalupe Island populations represent distinct subspecies; however the differences in body proportions may be just the result of environmental conditions. Until additional information concerning the genetic status of these populations is obtained, they will be treated simply as different at the population level.

Ecological Relationships

G. engrammus is a secretive form which at Punta Banda lives near and under the sea urchin *Strongylocentrotus franciscanus*. After this relationship was discovered, it was possible to locate specimens under about 50 per cent of the sea urchins pried off the rocks. The clingfish generally scurry away, usually heading for the next closest sea urchin, where they would dart under the protective cover of the spines. In the deeper water, the orange spots made it difficult to see the clingfish against the background of the spines. Seven clingfish were placed with sea urchins in an aquarium, where photographs of their hiding behavior were obtained (Fig. 3).

Figure 3. *G. engrammus* in close association with *Strongylocentrotus franciscanus*.

In captivity, clingfish readily took frozen brine shrimp which were fed to them by hand, and also fed on the isopods that live commensally on the sea urchins. To determine whether commensal isopods formed a major portion of the clingfish diet, we preserved in formalin stomachs of eight specimens collected at Punta Banda. Analysis showed that the major food items were amphipods; however, isopods, polychaetes, crabs, snails, cowries and limpets were also present. Since the specimens were collected at about 1000 hours, and the food items had undergone partial digestion and were well down the digestive tract, we suggest that the clingfish may be a nocturnal feeder, leaving the protection of the sea urchin at night.

Other species of small fishes found in close association with the clingfish include the cottids *Artedius corallinus*, *Artedius creaseri* and *Orthonopias triacis*, the ronquil *Rathbunella alleni*, and the klipfish *Gibbonsia montereyensis*.

Zoogeography

Gobiesox eugrammus was apparently derived from the more northern species *G. maeandricus*, which appears to be more primitive on the basis of the position of the posterior nostril (Briggs, 1955). Although *G. maeandricus* now is only found commonly north of Point Arguello, California, with a recorded range from San Diego, California, to British Columbia, it was probably distributed farther to the south during the Pleistocene when the water temperatures were generally cooler. Individuals are occasionally carried south by the California current, however, as evidenced by the capture of a 16.0 mm SL specimen attached to a piece of Giant Kelp, *Macrocystis*, between Guadalupe Island and the mainland at 28° 48′N, 115° 53′W (SIO-65-524-60A). This specimen extends the known range of *G. maeandricus* into Mexican waters.

G. eugrammus probably evolved from a population of *G. maeandricus* that became isolated after the cool waters moved northward at the close of the Pleistocene. It is not certain, however, whether the ancestral population of *G. eugrammus* evolved on Guadalupe Island and secondarily invaded the mainland, or whether the initial isolation occurred in areas of cold upwelling along the mainland of Baja California.

Acknowledgments

The authors are indebted to P. A. Adams, D. Hensley, and D. Wildrick for assistance in field work and to Carl L. Hubbs, John C. Briggs, and Richard H. Rosenblatt for critically reviewing the manuscript and making suggestions.

Literature Cited

BRIGGS, J. C.

1955. A monograph of the clingfishes (order Xenopterygii). Stanford Ichthyological Bull. 6: 1-224.

1965. The clingfishes (Gobiesocidae) of Guadalupe Island, Mexico. Calif. Fish and Game 51: 123-125.

ACCEPTED FOR PUBLICATION 22 AUGUST 1968

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S-NAE

FIVE NEW TAXA OF *HAPLOPAPPUS* (COMPOSITAE) FROM BAJA CALIFORNIA, MEXICO

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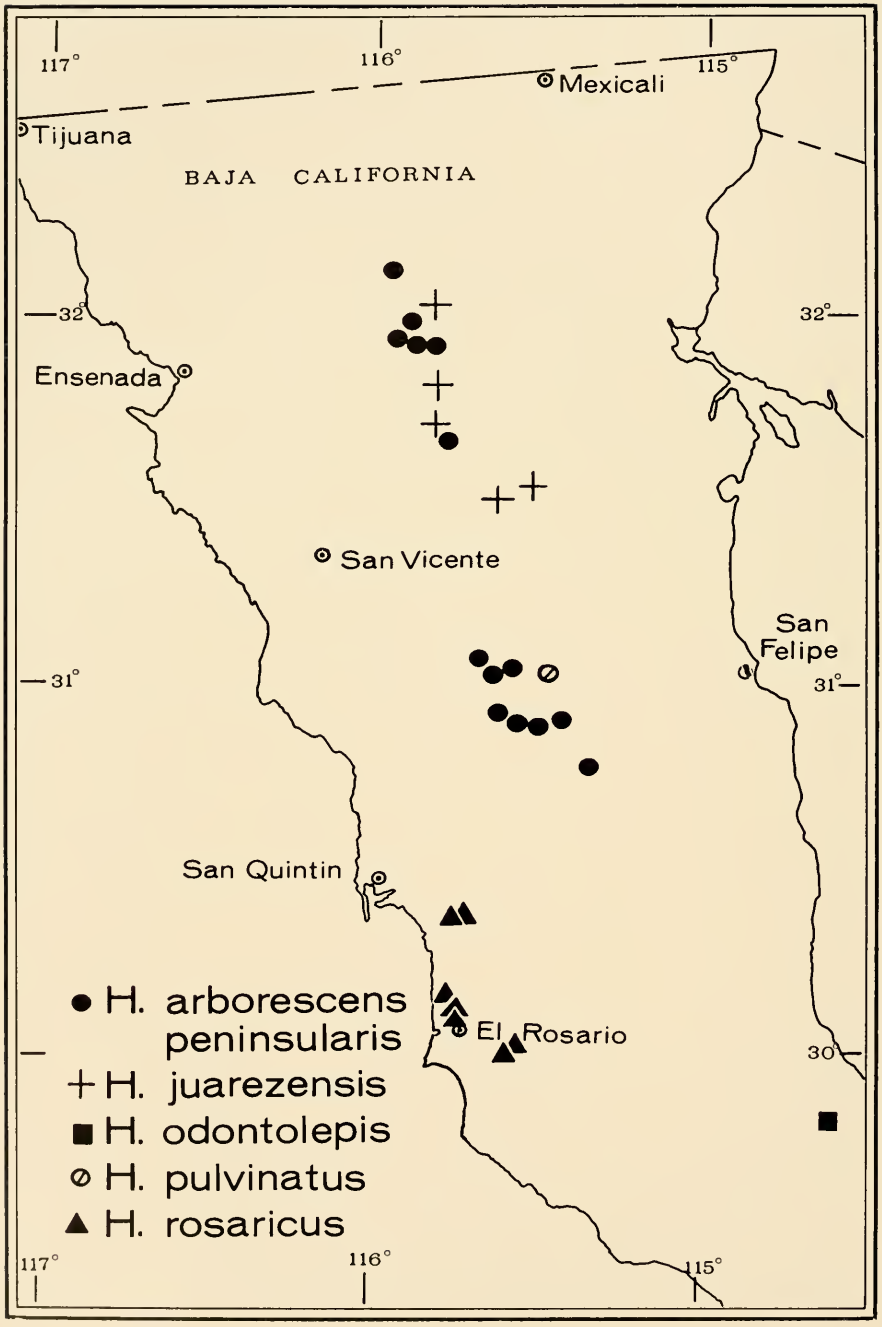

Figure 1. Northern Baja California, showing all known localities for the five new taxa of *Haplopappus*.

FIVE NEW TAXA OF *HAPLOPAPPUS* (COMPOSITAE) FROM BAJA CALIFORNIA, MEXICO

Reid Moran

Abstract. — The five new plants are distinguished from their nearest relatives as follows. *H.* (*Ericameria*) *arborescens* ssp. *peninsularis*, of the Sierra Juárez and Sierra San Pedro Mártir, differs from *H. arborescens* A. Gray ssp. *arborescens*, of northern California, in having 9-18 rather than 18-25 florets per head; it differs from *H. arborescens* ssp. *parishii* (Greene) Moran, of southern California, in having leaves 1½-3½ mm rather than 3-10 mm wide. *H.* (*Ericameria*) *juarezensis*, of the Sierra Juárez, differs from *H. martirensis* (Wiggins) Blake, of the Sierra San Pedro Mártir, in its broader leaves, smooth involucral bracts with a narrower herbaceous center, longer achenes, and more numerous pappus bristles. *H.* (*Hazardia?*) *odontolepis*, of Cerro Potrero, differs from *H. ternicosus* Brandegee, of the foothills of northwest Baja California, in its hispidulous herbage, sessile leaves, much larger heads with more numerous ray and disk florets, and apparently fertile disk florets. *H.* (*Hazardia*) *rosaricus*, of the El Rosario region, differs from *H. squarrosus* H. & A., of west central California to northwestern Baja California, in its thinner and more branching glabrous stems, more glutinous herbage with a lemony fragrance, smaller leaves, shorter and less exserted corollas, and shorter style branches, achenes, and pappus. *H.* (*Stenotus*) *pulvinatus*, of the high Sierra San Pedro Mártir, differs from others of the section in its smaller and discoid heads, with shorter corollas and achenes, borne on peduncles shorter than the leaves; from *H. acaulis* (Nutt.) A. Gray, of northwestern North America, it differs further in its smaller and thicker leaves with only the midrib evident, sparsely glandular but otherwise glabrous herbage, fewer disk florets, and shorter style branches.

Resumen. — Las cinco plantas nuevas se distinguen de sus parientes más cercanos, como sigue. *H.* (*Ericameria*) *arborescens* ssp. *peninsularis*, de la Sierra Juárez y Sierra San Pedro Mártir, difiere de *H. arborescens* A. Gray ssp. *arborescens*, del norte de California, por tener de 9 a 18 flósculos por cabezuela, en vez de 18 a 25; difiere de *H. arborescens* ssp. *parishii* (Greene) Moran, del sur de California, por tener hojas de 1½ a 3½ mm de ancho, en vez de 3 a 10 mm. *H.* (*Ericameria*) *juarezensis*, de la Sierra Juárez, difiere de *H. martirensis* (Wiggins) Blake, de la Sierra San Pedro Mártir, en sus hojas más anchas, suaves brácteas involucrales con un centro herbáceo más estrecho, aquenios más largos, y mayor número de cerdas del vilano. *H.* (*Hazardia?*) *odontolepis*, del Cerro Potrero, difiere de *H. ternicosus* Brandegee, de las vertientes al noroeste de Baja California, en sus ramas y hojas hispidulas, hojas sésiles, cabezuelas mucho más grandes con más numerosos flósculos del rayo y del disco, y flósculos del disco aparentemente fértiles. *H.* (*Hazardia*) *rosaricus*, de la región circunvecina a El Rosario, difiere de *H. squarrosus* H. et A., del occidente del centro de California al noroeste de Baja California, en sus tallos más delgados, más ramificados, y glabros, ramas y hojas más glutinosas, con fragancia a limón, hojas más pequeñas, corolas más cortas y menos exsertas, y ramas del estilo, aquenios, y vilano más cortos. *H.* (*Stenotus*) *pulvinatus*, de la alta Sierra San Pedro Mártir, difiere de las otras de la sección, en sus cabezuelas más pequeñas y discoidales, con corolas y aquenios más cortos, sustentadas por pedúnculos más cortos que las hojas; de *H. acaulis* (Nutt.) A. Gray, del noroeste de Norteamérica, difiere, además, en sus hojas más pequeñas y gruesas, siendo solo la nervadura central evidente, y esparcidamente glandulares pero de otra manera glabras, menos flósculos del disco, y ramas del estilo más cortas.

The genus *Haplopappus* Cass., competently monographed by H. M. Hall (1928), is now under critical cytotaxonomic study by Dr. R. C. Jackson and associates. There would seem to be plenty of taxonomic problems for everybody, and I would not go out of my way to poach in another botanist's territory. However, in the course of general collecting in the state of Baja California, which is more my territory, I have happened

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to find five new plants of this genus and have been able to study them in comparison with related species in the same area.

In the citation of specimens, field numbers are mine unless otherwise identified. Herbaria are cited mainly for duplicates already sent out (if not yet incorporated); other duplicates are yet to be sent.

Haplopappus arborescens (A. Gray) H. M. Hall ssp. **peninsularis** Moran, subspec. nov. (Fig. 2)

A subspecie typica involucri bracteis 15-20 floribusque 9-14 (-18) et a subspecie parishio[1] *foliis angustioribus, maximis 1½-3½ mm latis, differt. Typus:* Moran 13554 *(SD 65769).*

Figure 2. Flowering branches of *Haplopappus arborescens* ssp. *peninsularis*, × 0.75; part of the type collection, from south of El Rayo, Sierra, Juárez, September 1966.

Rounded shrub 1-2½ m high, the stem to 1 dm thick at the base, the bark dark gray or almost black. Leaves linear, acute, the largest 3-6½ cm long, 1½-3½ mm wide, ca. ½ mm thick. Flowering shoots ½-2½ dm long, the cymes 1½-5 cm wide, flowering August to October. Involucres 4-5½ mm high, 2-3 (or, when pressed, to 4) mm wide, of 15-20 bracts. Disk florets 9-14 (-18); rays none. Corolla 4-6 mm long. Achenes 1½-2½ mm long, the pappus 3½-5 mm long. Gametic chromosome number: $n=9$.

Type collection. — Rare in the chaparral at 1600 meters elevation, 2 miles south of El Rayo, Sierra Juárez, Baja California, Mexico (near 31°58′N, 115°58′W), 17 September 1966, *Moran 13554* — holotype: SD 65769; isotypes: CAS, UC, US, etc.

[1] *Haplopappus arborescens* ssp. *parishii* (Greene) Moran, comb. nov. *Bigelovia parishii* Greene, Bull. Torrey Club 9: 62. 1882.

Distribution. — Generally scarce, mostly in chaparral, central part of the Sierra Juárez at 1150 to 1750 meters elevation and western slope of the Sierra San Pedro Mártir at 1200 to 2200 meters, Baja California. Collections: Sierra Juárez: 6 miles north of Laguna Hansen, 1700 m, *13608* (SD); 5 miles southeast of the sawmill on the road to La Botella, 1750 m, *13606* (DS, ICF, KANU, SD, UC); 2½ miles west of La Botella, 1750 m, *13511* (DS, SD, UC, US, etc.); 1½ miles west of La Botella, 1750 m, *13599a* (ICF, KANU, SD, UC), *13599b-k* (SD); granitic wash near Mission Santa Catarina, 3700 feet, *Breedlove 4213* (DS). Sierra San Pedro Mártir: 7000 feet, *Brandegee* in 1893 (UC); foothills, 4000 feet, *Robertson 48* (UC); north slope of Cerro Blanco, 1200 m, *14533* (KANU, SD); above Rancho San Pedro Mártir on road to Corral de Sam, 1900 m, *Moran & Thorne 14115* (DS, RSA, SD, UC, US, etc.); 1 mile east of Corral de Sam, 2200 m, *15530* (KANU, SD); Rancho San Pedro Mártir, 1700 m, *14566* (SD); south of La Corona, 2150 m, *11304* (DS, ICF, SD, UC); 1½ miles west of Encinal, 1200 m, *Moran & Thorne 14508* (KANU, RSA, SD); Vallecito de la Canoa, 1900 m, *Moran & Thorne 14504* (DS, RSA, SD); west of La Grulla, 2100 m, *Moran & Thorne 14502* (RSA, SD); La Encantada, 2200 m, *Wiggins & Demaree 4952* (DS), *Moran & Thorne 14368* (CAS, RSA, SD, UC, US, etc.); Santa Rosa, 2050 m, *Moran & Thorne 14419* (DS, RSA, SD, UC, US).

Discussion. — *Haplopappus arborescens* ssp. *arborescens* occurs mainly in northern and central California — in the Sierra Nevada from Nevada County to Fresno County and in the Coast Ranges from the Oregon line to Ventura County. *Haplopappus arborescens* ssp. *parishii*[1] occurs in southern California — from the San Gabriel Mountains of Los Angeles County and the San Bernardino Mountains of San Bernardino County to Otay Mountain and the Cuyamaca-Laguna Mountains of San Diego County. *Haplopappus arborescens* ssp. *peninsularis* occurs in northern Baja California — in the central part of the Sierra Juárez and on the west slope of the Sierra San Pedro Mártir. It grows mostly towards the upper limit of the chaparral, often in disturbed areas, and generally is scarce. In the Sierra Juárez it seems to be local: I have found it only within about 8 miles of Laguna Hansen, but one collection is from 26 miles to the south. There appear to be no more northern collections, though C. R. Orcutt in particular explored the northern part of the Sierra for plants at various seasons, making one trip in September and another in October, when the plant would have been in flower and very conspicuous. I found it relatively common only in one area, about 3 to 5 miles southeast of the sawmill on the road to La Botella. In the Sierra San Pedro Mártir, again it is scarce. The cited collections represent all localities at which Dr. R. F. Thorne and I saw this plant on an 8-day, 60-mile collecting trip through the Sierra. The most plants we saw in one area were about 25, scattered along some 2 miles of trail between Rancho San Pedro Mártir and Corral de Sam.

In number of florets per head, *H. a. parishii*, with 9 to 12 or rarely 16, is quite distinct from *H. a. arborescens*, with 18 to 25. Also, the number of involucral bracts seems to be correspondingly smaller. In *H. a. peninsularis* the inflorescence tends to be smaller than in *H. a. parishii*, in which the floral shoots are 1 to 5 dm long and the cymes 2 to 18 cm wide; but the heads are very similar. There too, the number of florets is commonly 9 to 12 and rarely 16 or more. In one collection of *H. a. peninsularis* (*13599*), besides several plants with smaller numbers, three had 11 to 14, one had 13 to 16, and one had 10 to 18.

In leaf width also, *H. a. parishii*, with the largest leaves 3 to 10 mm wide, is quite distinct from *H. a. arborescens*, with leaves rarely more than 2 mm wide. Here *H. a. peninsularis* is intermediate, with the largest leaves 1½ to 3½ mm wide. Most specimens

of *H. a. parishii* are quite distinct from the ssp. *peninsularis*, having the largest leaves over 5 mm wide; but some, especially from San Diego County, have narrower leaves, and a few have no leaves over 3 mm wide. It is true that some of these specimens were collected late in the season and have only the narrower upper leaves left. But a quick sampling of four populations (*13716, 13718, 13719, 13721*) in the Cuyamaca-Laguna Mountains shows that, as might be expected, individuals vary in leaf width and that a few individuals at flowering time may have no leaves more than 3 mm wide. Specimens from such plants apparently cannot be distinguished from the broader-leaved specimens of *H. a. peninsularis*. However, San Diego County specimens that cannot be distinguished by leaf width evidently are just extremes from a population of mostly wider-leaved plants and so are best referred to *H. a. parishii* on the basis of distribution. The line between these two subspecies thus is conveniently drawn at the international boundary, where there is an apparent 50-mile break in the distribution.

Haplopappus parishii has always been treated as a species separate from *H. arborescens*. Hall (1928) pointed out that it scarcely differs except in the decidedly smaller number of florets and the broader leaves; but the two are quite distinct in these respects as well as geographically. Clearly *H. a. peninsularis*, though not intermediate geographically, does connect the other two in leaf width. Since some specimens are virtually identical, it can scarcely be treated as a species separate from *H. parishii*; and if it were treated as a subspecies of *H. parishii*, the gap between *H. arborescens* and *H. parishii* would thereby be reduced, the main remaining difference being in the number of bracts and florets. It therefore seems more reasonable to treat the three as subspecies of one species.

Dr. R. C. Jackson reports a gametic chromosome number of $n=9$ for collection 14368.

At Rancho San José, this plant is known as rama hechicera [witch's bush], and according to Mrs. Meling it is supposed to have some medicinal value.

Haplopappus juarezensis Moran, spec. nov. (Figs. 3, 4)

Frutex resinosus hispidulus ad 6 dm altus. Folia oblanceolata ad obovata, cuneata, obtusa, integra, coriacea, glanduloso-punctata, 5-15 mm longa. Capitula solitaria vel pauca subcorymbosaque, discoidea. Involucra turbinata, 5-10 mm longa, 3-5 mm lata, bracteis 20-35, ca. 4-seriatis, lanceolatis, acutis. Flores capituli 12-26, corollis 6-9 mm longis, ramis stylorum 2½-3½ mm longis. Achenia subcylindrica, vinacea, hirsuta, 4-5½ mm longa, pappo albo, 6-8 mm longo. Typus: Moran 13556 *(SD 63514). A* H. cuneato *et* H. martirensi *acheniis longioribus, pappi aristis numerosioribus et praeterea a priore ramulis foliisque hispidulis, foliis angustioribus, bracteis acutis, a posteriore foliis latioribus, involucri pedunculique bracteis levibus (in illo granuloso-glandulosis) differt.*

Stiff shrub 2-6 dm high and 5-12 dm wide, sympodially much branched, the stems to 3 cm thick at the base, the bark gray-brown, shreddy. Herbage hispidulous with septate conic trichomes ca. 0.1-0.2 mm long. Branchlets 2-7 (-17) cm long, the first year ca. ½-1 mm thick, green, hispidulous, pitted and very resinous, terete, inconspicuously lined downward from the midrib and margins of each leaf, each usually terminating with a head in late summer, the second fall sometimes still leafy, to 2 mm thick, tan, sometimes strongly angulate, with 1-3 or more ascending new shoots from upper axils; internodes averaging 1½-3 mm. Leaves sessile, oblanceolate to obovate, cuneate, broadly acute or mostly obtuse to rounded, entire, 5-15 mm long, 2-6 mm wide above, ½-1 mm wide at the base, ca. ½ mm thick, sparsely hispidulous, conspicuously glandular-pitted, the midrib not projecting but evident dorsally as a trans-

Figure 3. Flowering plant of *Haplopappus juarezensis* at the type locality, southeast of Las Filipenas, Sierra Juárez, September 1966.

lucent or glandular line, the lateral veins obscure. Heads discoid, yellow 11-14 (8-16) mm high, with 12-26 florets, flowering July to October, often solitary and terminal but sometimes also with 1-3 or more younger ones subcorymbose from the upper leaf axils, the peduncles 2-18 but mostly 5-10 mm long, slender, glabrous at least above, with small bracts transitional from the reduced upper foliage leaves to the involucral bracts. Involucres turbinate, 5-8 (-10) mm high, 3-5 mm wide, the bracts ca. 20-35, erect, in ca. 4 series, from triangular-lanceolate without to linear-lanceolate within, slender-acute, 1-1¼ mm wide, obtusely keeled, chartaceous with a narrow herbaceous or glandular midline, the margins scarious, somewhat erose, ascending-fimbriate above. Corolla 6-8 (-9) mm long, slender, gradually ampliate upward, glabrous or slightly puberulent on the tube, the lobes spreading, triangular-ovate, 0.8-1.2 mm long, glabrous. Style branches long-exserted, 2½-3½ mm long, slender, the appendage equalling or exceeding the stigmatic part. Achenes subcylindric but tapering slightly to the base, faintly 5-ribbed, purplish red, 4-5½ mm long, ca. 0.6-0.9 mm thick, densely ascending-pubescent with slender stiff hairs ca. 1-2 mm long. Pappus 6-8 mm long, of ca. 50-90 scabrous capillary bristles, white becoming slightly yellowish. Gametic chromosome number: $n=9$.

Type collection. — Occasional on granitic hills at about 1575 meters elevation, 5.0 miles by road southeast of Rancho las Filipinas, Sierra Juárez, Baja California, Mexico (near 31°47′N, 115°48′W), 17 September 1966, *Moran 13556* — holotype: SD 63514; isotypes: CAS, UC, US, etc.

Distribution. — Known only from a few scattered populations on rocky and gravelly slopes in the southern half of the Sierra Juárez at 1150 to 1600 meters elevation. Other collections: ½ mile southeast of Rancho Calabozo, 1600 m, *13488* (CAS, SD, UC, US, etc.), *13593* (DS, SD, UC, US, etc.), *13594* (CAS, SD); type locality,

Figure 4. Flowering branch of *Haplopappus juarezensis*, × 1.3; part of the type collection, from southeast of Las Filipinas, Sierra Juárez, September 1966.

9842 (DS, ICF, SD, UC); ½ mile south of La Cienega, 1350 m, *13698* (DS, SD, UC, US, etc.); Portezuelo de Jamau, 1300 m, *13671* (CAS, SD, UC, US, etc.), *13889* (SD); 1½ miles west of Rancho Alamito, 1150 m, *13634* (DS, SD, UC, US, etc.).

Discussion. — The new species is known only from five localities in the southern part of the Sierra Juárez; but the area is little known botanically, and the plant very likely is more widespread than the few collections might suggest. It is often associated with such plants as *Pinus monophylla* Torr. & Frem., *P. quadrifolia* Parl., *Juniperus californica* Carr., *Nolina palmeri* S. Wats., *Quercus peninsularis* Trel., *Q. turbinella* Greene, *Adenostoma fasciculatum* H. & A., *A. sparsifolium* Torr., and *Ceanothus greggii* var. *perplexans* (Trel.) Jeps.

Haplopappus juarezensis belongs to the section *Ericameria* (Nutt.) A. Gray. It most resembles *H. martirensis* (Wiggins) Blake, which is similar is size and habit, with similar pubescence and generally similar inflorescence and flowers. That differs from *H. juarezensis* most conspicuously in its much narrower leaves (¾-1½ mm wide), which give the plant a rather different appearance; the leaves also are more acute and mucronate, with obscure midribs. Furthermore, the involucral bracts and the upper bracts of the peduncles are granular-glandular rather than smooth; the involucral bracts have a broader herbaceous center; the achenes are shorter (ca. 3½-4½ mm long); and the pappus bristles are fewer (ca. 30-40). *Haplopappus martirensis* occurs in the Sierra San Pedro Mártir, the range immediately south of the Sierra Juárez, but at higher elevations than *H. juarezensis* — at least from 2000 to 2750 meters. It commonly grows in crevices of steep granitic faces.

Haplopappus juarezensis also resembles *H. cuneatus* A. Gray in habit and inflorescence, and they are the only members of the section with short entire leaves broader than

linear. It differs from *H. cuneatus* in its hispidulous herbage, narrower leaves, slender-acute involucral bracts, larger and red achenes, and more numerous pappus bristles. *Haplopappus cuneatus*, which ranges from the Sierra Nevada and Arizona to central Baja California, also occurs in the Sierra Juárez but mainly in the northern part, often at slightly greater elevations than *H. juarezensis* or in more shaded spots. At Rancho Calabozo, where the two occur together, *H. juarezensis* clearly favors drier and more exposed places. No hybrids were found.

At the three southern (and lower) localities, *H. juarezensis* occurs with *H. propinquus* Blake, another discoid *Ericameria*. That is a larger shrub, glabrous, with linear leaves, smaller heads, obtuse bracts, and smaller achenes. Again, no hybrids were found.

Dr. R. C. Jackson has made chromosome counts for collections 13556, 13593, 13634, 13671, and 13698. For each he reports a gametic chromosome number of $n=9$.

At Santa Catarina I was told that this plant is called hierba del pasmo. I have heard that name applied also to *H. cooperi* (A. Gray) Hall; but in Baja California it seems to be used mainly for *H. propinquus* Blake, a plant of widely reputed medicinal value. The same name was reported by Blake (1926) as used in Baja California and Sonora for *H. sonoriensis* Blake; but at Bahía de los Angeles that plant, which is not used medicinally, is called romerillo and is distinguished from the medicinal hierba del pasmo (*H. propinquus*), in that region occurring only in the higher mountains. The same name is reported as used in Mexico for various plants of other families; it presumably implies that the plants are considered as remedies for tetanus.

Haplopappus odontolepis Moran, spec. nov. (Fig. 5)

Fruticulus hispidulus resinosus 3 dm altus, ramulis e caule crasso dense adscendentibus. Folia sessilia, elliptica, spinoso-dentata, coriacea, glanduloso-punctata, 6-18 mm longa, 2-4 mm lata. Capitula solitaria vel pauca cymosaque, radiata, flava. Involucra cylindro-turbinata, 10-12 mm longa, 3-5 mm lata, bracteis ca. 25, exterioribus foliis similibus, spinoso-dentatis, squarrosis. Flores radii 6-8, ligulis 6-6½ mm longis. Flores disci 12-14, corollis 7½-8½ mm longis. Achenia radii discique (immatura) similia, 5-costata, pubescentia. Typus: Moran 12162 *(SD 61139). Species* H. vernicoso *affinis, sed ille subglaber basique gracilior, foliis subpetiolatis, capitulis minoribus, floribus paucioribus minoribusque, acheniis disci sterilibus multoque deminutis. Hae duae ab omniis congeneribus mihi notis involucri bracteis exterioribus dentatis valde differunt.*

Glutinous shrublet ca. 3 dm high, hispidulous with trichomes 0.1-0.2 mm long, with an erect stock 5-10 cm high and to 2½ cm thick bearing at the summit many crowded erect or ascending branches; first-year branches simple or few branched above, light tan, ca. 1 mm thick, angled from leaf margins and midrib downward, sparsely hispidulous, leafy throughout, with internodes averaging 2½-6 mm, and mostly with small leaves fascicled in the axils; older ones branching further, to 6 mm thick, the bark dark gray, shreddy, yellowish in the new fissures. Leaves sessile and subclasping, elliptic to cuneate-oblanceolate, acute, 6-12 (-18) mm long, (2-) 3-4 mm wide above, 1-2 mm wide at the base, coriaceous, glandular-pitted and slightly to heavily resinous, hispidulous but less so ventrally, the midrib white, prominent dorsally, the lateral veins obscure, the apex deflexed, tipped with a white spine, the margins ± crisped, each with 2-6 irregularly spaced spreading white spinose teeth ½-1 mm long, the first few leaves of the shoot smaller and entire. Heads solitary on the branches or on branchlets mostly more than 1 cm long, bright yellow. Involucres cylindric-turbinate, 10-12 mm long, 3-5 mm wide excluding the squarrose tips, of ca. 25 bracts; outer 8-10 bracts graduated, leaflike or transitional, the exposed upper part herbaceous, glandular-pitted, 2-4 mm wide, with

Figure 5. Dried flowering branch of *Haplopappus odontolepis*, × 1.15; part of the type collection, from Cerro Potrero, May 1965.

marginal teeth and recurved spinose tip, the covered part stramineous, 1½-2 mm wide, ciliate; the inner ca. 15 bracts oblong to linear, acute, cartilaginous with margins narrowly scarious and erose-ciliate, 8-10 mm long, the outer of these ca. 2 mm, the inner ca. 1 mm wide. Ray florets 6-8; corolla tube 5-5½ mm long, the ligule 6-6½ mm long, 1.6-1.9 mm wide, irregularly 3-lobed for 1 mm or less; style branches linear, obtuse, 1-1½ mm long, stigmatic to the apex, unappendaged. Disk florets 12-14; corolla slightly ampliate, 7½-8½ mm long, the teeth triangular-ovate, 0.6-0.9 mm long; anthers 2½-3 mm long; style branches linear, acute, 1½-2 mm long, the puberulent appendage 1-2 times longer than the stigmatic part. Ray and disk achenes (immature) similar, 5-ribbed, ca. 2½ mm long, sparsely ascending-pubescent. Pappus of ca. 50 scabrous brownish-white bristles 4-5½ mm long.

Type collection. — Rare on the north slope at 1400 meters elevation, near the summit of Cerro Potrero, Baja California, Mexico (near 29°49′N, 114°37′W), 30 May 1965, *Moran 12162* — holotype: SD 61139; isotypes: CAS, GH, ICF, K, KANU, NY, UC, US.

Distribution. — Known only from the type collection.

Discussion. — Cerro Potrero is the rounded peak at the head of Arroyo Cataviñá and about 7 miles north-northwest of ex-misión Santa María. It has also been called Cerro Ugarte, but that name is not in local use. Though scarcely higher than another peak just south of Santa María, apparently it is the highest summit in the 100 miles between Cerro Chato, at the south end of the Sierra San Pedro Mártir, and the Sierra San Luis. Dominant shrubs at the summit and on the north slope of Cerro Potrero are *Salvia chionopeplica* Epling, *Juniperus californica* Carr., and *Eriogonum fasciculatum* Benth. Other characteristic plants are *Stipa speciosa* T. & R., *Yucca whipplei* ssp. *eremica* Epl. & Haines, *Quercus turbinella* Greene, *Ribes quercetorum* Greene, *Prunus ilicifolia*

(Nutt.) Walp., *Rhus ovata* Nutt., *Brickellia frutescens* A. Gray, *Eriophyllum confertiflorum* (DC.) A. Gray, *Haplopappus propinquus* Blake, and *Senecio lemmonii* A. Gray. In three hours on the summit of Cerro Potrero, I found only two plants of *Haplopappus odontolepis*. I did not find it on the slightly lower Cerro Santa María, about 5 miles to the south.

The new species is most similar to *H. vernicosus* Brandegee, native in the foothills from north of San Vicente to southeast of El Rosario at elevations of about 50 to 900 meters. That species was known to Hall (1928) only from two specimens of the type collection; and Wiggins (1964) commented that it was little known and apparently rare. In fact, it occurs at many localities in the foothill area, as shown by a score of recent collections, and usually is abundant where it occurs.

Haplopappus odontolepis resembles *H. vernicosus* in its slender and angled branches and its dentate and glandular-pitted elliptic or oblanceolate leaves, and the two are unique in the genus in their spiny-margined leaflike outer involucral bracts. However, *H. odontolepis* differs from *H. vernicosus* in many respects. The branches are more crowded-ascending from a thicker base. The herbage is moderately hispidulous rather than very sparsely hispidulous or mostly glabrous. The leaves are not so conspicuously narrowed to a petiole-like base; and their marginal teeth are not so large, though the white spine ending each tooth is a little longer. The heads are more commonly solitary and are almost twice as long; and the toothed leaflike outer bracts, for which the species is named, are more numerous, larger, and more conspicuous. Both ray and disk florets are more numerous and somewhat larger. Immature achenes of the disk florets are like those of the rays, not greatly reduced as in *H. vernicosus*: probably disk as well as ray achenes are fertile.

Though noting that its herbage was not so clearly impressed-punctate as in other species, Hall (1928) placed *H. vernicosus* in *Ericameria* because of similarities to *H. cuneatus* A. Gray, especially in habit, leaf shape, and pappus. It thus became the only species in the section with toothed leaves and of course the only one with toothed involucral bracts. From the scanty insect-damaged material, Hall thought the disk achenes sterile and — perhaps a related condition — the style branches not differentiated into stigma and appendage; in these respects also the species would be unique in *Ericameria*. Ample material now confirms Hall's tentative view as to disk achenes and style branches.

Haplopappus odontolepis, which clearly is most similar to *H. vernicosus*, likewise would be anomalous in *Ericameria* because of its toothed leaves; furthermore, it has larger heads than any species included by Hall in *Ericameria*. However, disk achenes are like ray achenes and so presumably are fertile, and style branches of disk florets are appendaged. These facts suggest (1) that the lack of differentiation of style branches in disk florets of *H. vernicosus* is indeed related to sterility of achenes and (2) that the conditions of achenes and style branches in *H. vernicosus* are not germane to its sectional position since that species must in any case be placed with *H. odontolepis*, in which these are normal.

It now appears that the similarities of *H. vernicosus* to *H. cuneatus* are superficial and that *H. vernicosus* should be removed from *Ericameria* and placed with *H. odontolepis*, possibly in a section of their own. Mainly on the basis of gross morphology, but with support from a chromosome count for *H. vernicosus*, Dr. Jackson suggests that these two belong to section *Hazardia* or are closely related to it.

Haplopappus rosaricus Moran, spec. nov. (Fig. 6)

Frutex glaber glutinosus fragrans 2-9 dm altus, ramis gracilibus, angulatis. Folia spatulata, spinoso-dentata, coriacea, glanduloso-punctata, 1-2½ cm longa, 5-12 mm lata.

Figure 6. Flowering branch of *Haplopappus rosaricus*, × ca. 1.0; part of the type collection, from southeast of El Consuelo, July 1967.

Capitula thyrsoidea, discoidea, flava. Involucra turbinata, 8-10 mm longa, 3½-5 mm lata, bracteis 35-60, 5-8-seriatis, erectis, oblongis, mucronatis, ca. 1 mm latis. Flores capituli plerumque 17-23, corollis glabris, 5½-6½ mm longis, ramis stylorum 1.1-1.5 mm longis, appendicibus ovatis. Achenia fusiformia, 5-costata, adpresso-pubescentia, 3-3½ mm longa, pappi aristis ca. 25-40, scabris, 5-6 mm longis. Typus: Moran 14020 *(SD 65765). Species* H. squarroso *proxima sed caulibus brevioribus glabris basique ramosioribus, foliis minoribus glutinosioribus basique attenuatis, involucri squamis erectis, corollis ramis stylorum achenibus pappoque brevioribus differt.*

Glabrous, glutinous, lemony-fragrant shrub 2-9 dm high and 2-13 dm wide, with many slender erect or closely ascending branches from a base 1-2 cm thick. Branches zigzag, angled from the leaf margins and midrib downward, at first tan, very glutinous and somewhat granular, ca. 1 mm thick, becoming gray and to 3 mm thick, the internodes averaging ca. 5-15 mm, the axils sometimes with a few fascicled small leaves. Leaves sessile or subpetiolate, obovate to spatulate, obtuse to rounded, 1-2½ cm long, 5-12 mm wide above, 1-2 mm wide at the base, coriaceous, conspicuously glandular-pitted or in youth somewhat rugose, heavily glutinous, green or sometimes whitish with the dried exudate, spinose-tipped and dentate with 2-8 teeth on each margin, though sometimes entire in the lower half, the teeth deltoid, ½-1½ mm long, each tipped with a conic white spine, the midrib inconspicuous but in dried leaves whitish and protruding dorsally, the lateral veins obscure. Heads discoid, yellow, 9-13 mm high, with 12-30 but commonly 17-23 florets, flowering June to October, terminal and solitary or mostly thyrsoid, with 1-2 sessile or short pedunculate in each upper axil, the youngest below. Involucres turbinate, 8-10 mm high, 3½-5 mm wide, of ca. 35-60 bracts closely imbricated in 5-8 series, the bracts erect or with the tips slightly spreading, chartaceous

with scarious margins and short herbaceous tips, glandular internally as well as externally near the apex, erose and weakly spinose-mucronate at the apex, ca. 1 mm wide, the outer oblong, the inner linear-oblanceolate. Corolla 5½-6½ mm long, glabrous, gradually widening ca. from ½ mm at the base to 1 mm at the apex, the lobes erect, triangular-ovate, acute, 0.6-0.9 mm long. Style branches 1.1-1.5 mm long, the appendage ovate, acute, puberulent, half as long as to nearly equalling the stigmatic part. Achenes subterete, narrowed at base and somewhat at apex, 3-3½ mm long, reddish black, with 5 prominent white ribs, rather sparsely appressed pubescent. Pappus 5-6 mm long, of ca. 25-40 scabrous unequal bristles, white in flower but becoming sordid. Gametic chromosome number: $n=5$.

Type collection. — Locally common on north slope at 75 meters elevation, Arroyo del Campo Viejo, 2.3 miles southeast of El Consuelo and 7.2 miles north-northwest of El Rosario, Baja California, Mexico (near 30°09½'N, 115°46½'W), 2 July 1967, *Moran 14020* — holotype: SD 65765; isotypes: CAS, UC, US, etc.

Distribution. — On north slopes and higher ridgetops in the foothills within 12 miles of the sea, from northeast of El Socorro to southeast of El Rosario, at 75 to 475 meters elevation; often rather abundant. Other collections: 5 miles west of Rancho el Ciprés, 350 m, *14037* (DS, KANU, SD); 4 miles ENE of El Socorro, 150 m, *14035* (CAS, SD, UC, US, etc.); canyon north of El Rosario, *Gander 9598* (CAS, SD); 3 miles north of El Rosario, 200 m, *14021* (DS, SD, UC, US); ½ mile north of El Rosario, 75 m, *14022* (KANU, SD); 7 miles west of El Aguajito, 240 m, *15384* (CAS, SD, UC, US, etc.); divide 9 miles ESE of El Rosario on road to Puerto San Carlos, 475 m, *11242* (DS, ICF, RSA, SD, UC), *14025* (CAS, SD, UC, US, etc.).

Discussion. — *Haplopappus rosaricus* is rather abundant at most places where it occurs. Common associates at most of the localities are *Agave shawii* Engelm., *Rosa minutifolia* Engelm., *Euphorbia misera* Benth., and *Ambrosia chenopodiifolia* (Benth.) Payne. Other species of *Haplopappus* with which it sometimes grows are *H. propinquus* Blake, *H. venetus* ssp. *oxyphyllus* (Greene) Hall, and *H. vernicosus* Brandegee. No hybrids were noted.

Haplopappus rosaricus is most closely related to the polytypic *H. squarrosus* H. & A., whose southern subspecies *grindelioides* (DC.) Keck extends south at least to within 40 miles of the range of *H. rosaricus*. In *H. squarrosus*, the plant is generally larger and less branched, the base thicker (to 9 cm), the branches taller (to 1½ meters) and thicker. Various parts, but especially the stems, are pubescent, at least in those southern forms that otherwise more closely approach *H. rosaricus*. The herbage is less glutinous and has a different odor, not so sweet and lemony. The leaves are larger (ca. 1½-6 × 1-3 cm), and they tend to be broader and clasping at the base. The involucre is sometimes larger, and its bracts are commonly squarrose. The corolla is longer (7-11 mm) and more exserted; the style branches are longer (1.7-ca. 3 mm); the achenes are longer (3-5 mm or more) and often glabrous; and the pappus is longer (6-12 mm).

Dr. R. C. Jackson reports a gametic chromosome number of $n=5$ for collection 14025.

Several natives of El Rosario knew no name for this plant. However, one man said that it was used in a remedy for toothache.

Haplopappus pulvinatus Moran, spec. nov. (Fig. 7)

Planta caespitosa ad 18 cm lata in rupium rimis. Folia 10-20 subrosulata, coriacea, linearo-oblanceolata, acuta, integra, sparsim glandulosa, 1-1½ cm longa, ca. 1 mm lata, basi subamplectentia. Capitula solitaria, discoidea, flava, pedunculo foliis breviore. In-

Figure 7. Flowering plant of *Haplopappus pulvinatus* at the type locality, Cerro "2828", Sierra San Pedro Mártir, July 1968.

volucra turbinata, 5-7½ mm longa, 4-5 mm lata, bracteis 20-33, 3-4-seriatis, ellipticis ad lanceolatis, acutis, marginibus scariosis, exterioribus ca. 1 mm interioribus ca. 1½ mm latis. Flores capituli 14-36, corollis glabris, 3½-6 mm longis, ramis stylorum linearibus, acutis, 1.3-2.1 mm longis. Achenia 1½-3 mm longa, hirsuta, pappo albo, 2½-5 mm longo. Typus: Moran 15262 *(SD 68466). Ab aliis sectionis* Stenoti *capitulis minoribus discoideisque, corollis acheniisque brevioribus, pedunculisque foliis brevioribus differt; et a* H. acauli *foliis minoribus crassioribus praeterque glandes dispersas glabris, costa solum conspicua, disci floribus paucioribus, ramisque stylorum brevioribus praeterea differt.*

Plant forming a flat or convex cushion to 10 or rarely 18 cm wide, the stems closely branching, the interstices commonly packed with soil, the surface green with crowded leaf rosettes. Stems to 6 mm thick at the base, with brown bark, the branchlets 1-2 mm thick, each with ca. 10-20 crowded leaves at the apex and densely covered below with old leaves that are at first white or tan and later dark brown. Leaves ascending and commonly outcurved, coriaceous, green, linear-oblanceolate, acute, entire, channelled ventrally, 1-1½ cm long, ¾-1¼ mm wide above, a quarter to half as wide just above the broadened clasping base, sparsely beset with trichomes less than 0.1 mm long each tipped with a yellowish viscid globule ca. 0.5 mm thick, the midrib prominent, protruding dorsally, a parallel nerve on each side obscure except at the base, the apex subconic, whitish. Peduncles terminal, shorter than the leaves, ca. ½ mm thick, angled, sparsely glandular, with a few linear, acute, decurrent bracts decreasing in size upward, the upper ca. 3 mm long. Heads solitary, discoid, yellow, 7-9 mm high, with 14-36 florets, flowering in June and July. Involucre turbinate to narrowly campanulate, 5-7½ mm long, 4-5 mm wide (5-9 mm wide pressed), of 20-33 erect bracts imbricated in 3-4 series, the bracts elliptic to lanceolate, chartaceous below, green above, with scarious margins, the outer ca. 1 mm wide, acute, often sparsely glandular-ciliate, the inner ca. 1½ mm wide, mostly more broadly acute, usually fimbrillate above. Corollas glabrous, 3½-6 mm long, 0.3-0.4 mm wide at the base and slightly ampliate above, the lobes triangular-lanceolate, acute, 0.9-1.4 mm long. Style branches linear, acute,

1.3-2.1 mm long, the appendage usually exceeding and often twice exceeding the stigmatic part. Achenes light brown, with 5-8 unequally spaced low whitish ribs, 1½-3 mm long, ca. ½ mm thick and tapering to the base, hirsute with ascending white trichomes ½-1 mm long. Pappus 2½-5 mm long, of 25-35 unequal scabrous white bristles. Somatic chromosome number: $2n=18$.

Type collection. — Rather scarce, in crevices of east- and north-facing rocks and cliffs at 2800 meters elevation, east slope below Cerro "2828", east rim of the Sierra San Pedro Mártir, Baja California, Mexico (near 31°02′N, 115°27′W), 5 July 1968, *Moran 15262* — holotype: SD 68466; isotypes: CAS, GH, K, KANU, MEXU, RSA, UC, US.

Distribution. — Known only at the type locality.

Discussion. — The new species seems rather rare and limited as to habitat: despite wide collecting in the area on several trips, I could find only a dozen plants, all on the east slope of the one peak. Associated plants include *Selaginella asprella* Maxon, *Sedum niveum* Davids., *Heuchera leptomeria* var. *peninsularis* Rosend., Butt., & Lak., *Saxifraga eriophora* S. Wats., *Potentilla wheeleri* S. Wats., *Tanacetum* sp., and *Stephanomeria* sp.

Haplopappus pulvinatus belongs in the section *Stenotus* (Nutt.) A. Gray (as suggested by Dr. Jackson *in lit.*), even though it differs from previous members and hence from Hall's (1928) diagnosis in its pulvinate and scarcely subshrubby habit and in its discoid heads. It differs from the others also in having peduncles shorter than the leaves; and it further differs from each of them, at least on the average if not in each case absolutely, in having smaller heads, shorter corollas, and shorter achenes. In fact, it represents an extreme of reduction and compaction for the section *Stenotus*.

Haplopappus pulvinatus appears closest to *H. acaulis* (Nutt.) A. Gray, native from Saskatchewan to Colorado and east central California. The smaller-leaved and more densely caespitose forms of that variable species approach *H. pulvinatus* in habit, the stems and leaves are sometimes similarly glandular, and the involucral bracts are nearly as many and in about three series. However, the leaves are wider and often longer, with the lateral veins more evident, and are scaberulous at least on the margins and often throughout; the disk florets are more numerous; and the style branches are longer.

In size and shape of leaves, *H. pulvinatus* more nearly resembles *H. stenophyllus* A. Gray, native from Washington and Idaho to Nevada and northeastern California. In that species, however, the leaves are more scattered; the stems, leaves, and bracts are densely glandular-scabrid; the involucral bracts are fewer and nearly equal; and the corollas are puberulent.

Haplopappus macleanii Brandegee, of the Yukon Territory, is similar to *H. pulvinatus* in having small but thick leaves. However, the stems are more elongate; the leaves are narrower, hispid-ciliate, and more numerous on the stems; and the involucral bracts are fewer and more nearly equal.

On 25 August 1968 I collected achenes at the type locality from a plant that had provided part of the type collection. From these Dr. R. C. Jackson reports a somatic chromosome number of $2n=18$.

ACKNOWLEDGEMENTS

I am grateful to Drs. R. C. Jackson, Peter Raven, and Robert F. Thorne for critically reviewing the manuscript and to Biologist Mario Sousa S. for preparing the Spanish summary. Dr. Jackson also has kindly provided the chromosome counts reported here. And I am indebted to the Moran Travel and Contingency Fund for supporting the field work.

Literature Cited

Blake, S. F.
1926. Asteraceae. *In* Paul C. Standley, Trees and shrubs of Mexico. Contr. U. S. Natl. Herb. 23: 1401-1641. [The vernacular names contributed chiefly by Paul C. Standley.]

Hall, Harvey M.
1928. The genus *Haplopappus*: a phylogenetic study in the Compositae. Carnegie Inst. Publ. 389: i-viii, 1-391, figs. 1-114, pls. 1-16.

Wiggins, Ira L.
1964. Flora of the Sonoran Desert, p. 187-1740. *In* Forrest Shreve and Ira L. Wiggins, Vegetation and flora of the Sonoran Desert. Stanford University Press.

Accepted for Publication 15 November 1968

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FOSSIL GROUSE OF THE GENUS *DENDRAGAPUS*

JOSEPH R. JEHL, JR.

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VOL. 15, NO. 12 12 FEBRUARY 1969

FOSSIL GROUSE OF THE GENUS *DENDRAGAPUS*

Joseph R. Jehl, Jr.

Abstract. — Osteological variation in the Pleistocene and Recent populations of *Dendragapus* is reviewed. Two species of *Dendragapus* are recognized from late Pleistocene deposits of the western United States. *Dendragapus lucasi*, which was smaller than the extant *D. obscurus*, and *D. g. gilli*, a large, heavy-bodied grouse, are known only from Fossil Lake, Oregon. *D. nanus*, also described from the Fossil Lake deposits, is considered a synonym of *D. lucasi*. Another grouse, known from cave deposits of northern California, is tentatively described as a small, southern subspecies of *gilli*, *Dendragapus gilli milleri* n. subsp. Phylogenetic relationships between the Pleistocene grouse and *D. obscurus* are not currently resolvable.

Grouse of the genus *Dendragapus*[1] are not common in the fossil record. Three forms, *Dendragapus lucasi* (Shufeldt), *D. nanus* (Shufeldt), and *D. gilli* (Shufeldt) are known only from late Pleistocene deposits at Fossil Lake, Lake County, Oregon. These fossils seem to have been collected from a narrow series of beds with a maximum age of approximately 29,000 years (Allison, 1966). Abundant material referred to the extant Blue Grouse, *D. obscurus*, was reported by Miller (1911) from the Samwel and Potter Creek cave deposits of Shasta County, California. These deposits are of Upper Pleistocene age, but they have not been precisely dated. The locations of the Pleistocene deposits are shown in Figure 1. *Dendragapus obscurus* has also been reported from an Indian midden in the Puget Sound region, Washington (Miller, 1960), and from the Weiss and Birch Creek Valley rock shelters in Idaho (Miller, 1963). Carbon 14 dating indicates a maximum age of 10,000 to 12,000 years for the Idaho remains.

For an earlier study (Jehl, 1967) it was necessary to assemble most of the Fossil Lake *Dendragapus* material previously studied by Howard (1946), the largely unstudied California cave fossils, and a large series of skeletons of modern *D. obscurus*. Because osteological variation in *obscurus* proved to be greater than had been recognized previously, I restudied the differences on which the fossil species had been based in light of this variation. In this paper I review the fossil populations of *Dendragapus* and I attempt to outline their possible relationships to each other and to *D. obscurus*.

Materials

I examined the following skeletal material representing seven of the eight currently recognized races (A.O.U., 1957) of *Dendragapus obscurus: D. o. richardsoni*, 1 complete and 2 partial females, 3 complete males; *D. o. pallidus*, 1 complete and 2 partial females, 1 complete male; *D. o. oreinus*, 3 complete and 2 partial females, 1 complete and 1 partial male; *D. o. fuliginosus*, 5 complete females, 4 partial males; *D. o. sitkensis*, 1 partial female; *D. o. sierrae*, 3 complete and 3 partial females, 5 partial males, 1 unsexed; *D. o. howardi*, 3 partial males. Fossil material examined is indicated below under "Referred material" and includes all known material from Fossil Lake examined

[1]Short (1967) has recently proposed that *Canachites* and *Falcipennis*, genera recognized by Peters (1934), be placed in an expanded genus *Dendragapus*. In this paper I use *Dendragapus* in its traditional sense. However, except for a single report of *Canachites canadensis* from the late Pleistocene of Virginia (Wetmore, 1962: 7-8) there is apparently no fossil record of either *Canachites* or *Falcipennis* (Brodkorb, 1964).

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by Howard with the exception of two elements of *D. lucasi* (1 coracoid, 1 tarsometatarsus) in the Oregon State University collections (Howard, 1946: 179).

The following abbreviations are used: AMNH, American Museum of Natural History: UCMP, University of California Museum of Paleontology; UMMP, University of Michigan Museum of Paleontology.

Figure 1. Pleistocene localities of *Dendragapus* remains.

Identification of Dendragapus *material.* — Howard (1946: 179) has correctly emphasized that there is great variation in the bones of modern species of grouse, which may lead to difficulty in identifying fossil material. *Dendragapus* bones are no exception, and there are few characters by which individual elements of this genus can be distinguished from those of *Pedioecetes, Tympanuchus,* and *Centrocercus.* The humeri, femora, tibiotarsi, and carpometacarpi of *Dendragapus* are more robust than those of the other named genera. The ulnae are heavier and more strongly curved. The tarsometatarsi are somewhat more distinct; the shaft averages wider, the anterior metatarsal groove shallower and less elongated, and the trochleae heavier. The coracoids are similar to those of the other genera, but the antero-ventral process of the furcular facet, in ventral view, is thicker, blunter, and less recurved toward the shaft.

Races of modern *Dendragapus obscurus* are based largely on color variation (Friedman, 1946: 69), though there is an eight to ten per cent difference in wing lengths

between the largest and smallest races. Too few skeletons are available for the races to be characterized osteologically. However, I can detect no racial differences in the skeletons at hand. All show the robustness characteristic of the species, and there is no demonstrable geographic variation in robustness.

Dendragapus FROM FOSSIL LAKE

Shufeldt (1892) described two species of grouse from Fossil Lake, Oregon, *lucasi* and *nanus*, which he assigned to the genus *Pediocetes*. Howard (1946) reassigned both species to *Dendragapus* on the basis of tarsal characters. Other characters, namely the stoutness of the carpometacarpi and the shape of the furcular facet, confirm her reallocation. Shufeldt (1892) erected a new genus, *Palaeotetrix*, for a third species, *gilli*, but this genus is not separable from *Dendragapus* (Jehl, 1967).

Dendragapus lucasi

Among the galliform birds present in the Fossil Lake deposits, this species was second in abundance only to the Sage Grouse (*Centrocercus urophasianus;* Howard, 1946). *Dendragapus lucasi* was somewhat smaller than modern *D. obscurus*. *All elements*, except one slightly shorter tarsometatarsus, fall within the size range and proportions of *female D. obscurus*. There is marked sexual size dimorphism in grouse, with males averaging larger than females. The apparent small size of *lucasi* probably is not an artifact of sampling, however, as it is unlikely that a sample of 20 elements from at least six individuals was derived entirely from female birds.

The ulna, coracoids, humerus, carpometacarpi, and femur of *lucasi* are indistinguishable from those of female *obscurus*. Howard (1946: 180) suggested two characters, "relatively less depth of proximal end and less development of the intermetacarpal tuberosity," by which carpometacarpi of *lucasi* were thought to differ from those of *obscurus*. However, she presented no quantitative data in support of the first character, and I find that the great variation in the large series of *obscurus* at hand encompasses that exhibited by elements assigned to *lucasi*. Furthermore, in *obscurus* the development of the intermetacarpal tuberosity is perhaps the most highly variable feature of the carpometacarpus; the development of this structure in *lucasi* is quite within the range of variation exhibited in *obscurus*.

The tarsometatarsi of *lucasi* are also extremely similar to those of *obscurus* but show several minor average differences: the metatarsal facet is smaller and more clearly defined proximally; the area below the internal cotyla on the posterior face is less deeply excavated; and the ridge bordering this depression, running between the internal cotyla and the metatarsal facet, is less well defined. The trochleae average smaller than in *obscurus*, but the symmetry of the distal end of the tarsometatarsus and the position of the internal trochlea (cf. Howard, 1946: 180) are within the range of variation of *obscurus*. Also, I detect no difference in the depth of the internal edge of the shaft, nor in the depth and prominence of the hypotarsus (cf. Howard, 1946). The morphology of the hypotarsus is somewhat variable in *obscurus* and includes the variation exhibited by *lucasi*.

In summary, *Dendragapus lucasi* may be characterized as a Pleistocene *Dendragapus* differing from the modern *D. obscurus* only in over-all size and in minor characters of the tarsometatarus.

Referred material. — Ulna-1 (AMNH no. 3476, Type). Carpometacarpus-7 [UCMP no. 31748, previously tentatively referred to *D. nanus*, see explanation below; AMNH nos. 3475A (2), 3477A (2), 3478A (2)]. Tarsometatarsus — 8 [AMNH nos. 3475 (2), both previously referred to *D. nanus*; 3475A (4), 3476 (2)]. Coracoid — 2 [AMNH no. 3478A (2)]. Humerus — 1 (AMNH no. 3478A). Femur — 1 (UCMP no. 31781). Tentatively referred. — Radius — 1 (UCMP no. 31776).

Dendragapus nanus

According to Shufeldt's (1892: 414) original description *D. nanus* differed from *D. lucasi* "only in the matter of size," *nanus* being smaller. However, this distinction is no longer valid. Howard (1946) reassigned four tarsometatarsi and two carpometacarpi from *nanus* to *lucasi,* retaining only two tarsometatarsi (AMNH no. 3475) and, tentatively, one carpometacarpus (UCMP no. 31748) in *nanus.* All of these elements are within the size range of *D. lucasi.*

Howard (1946) considered the carpometacarpus of *nanus* to differ from those of *obscurus* (and, by implication, from those of *lucasi*) in having "the external surface of the proximal end . . . less rugose and the process of metacarpal I . . . more markedly tilted upward." However, I could not confirm these differences when I compared the carpometacarpus of *nanus* with a large series of *obscurus.* Tarsometatarsi of *nanus* were said to resemble those of *obscurus,* and consequently to differ from those of *lucasi,* by having a "short, prominently projecting hypotarsus." As noted above, variation in the hypotarsus in *obscurus* is too great to make this character of diagnostic value. Howard also stated (p. 180) that tarsi of *nanus* differed from those of *obscurus* by the "(1) extreme proximal location of tubercle for tibialis anticus muscle; (2) more symmetrically flared distal end; and (3) relatively more slender shaft." Again, variation in *obscurus* includes the differences by which *nanus* was distinguished. In some *obscurus* the position of the tubercle is as far proximal, and in one *lucasi* it is more proximal; the symmetry of the distal end is variable and some tarsi of *obscurus* match those of *nanus* exactly; the ratio of least lateral width of the shaft to total length of the tarsometatarsus does not indicate that the element was slenderer in *nanus* than in *obscurus* (Table 4).

In summary, I find no characters except smaller size that allow elements previously assigned to *D. nanus* to be differentiated from *D. obscurus.* Unfortunately, the sample of *nanus* is too small to indicate whether the tarsal characters that seem to distinguish *lucasi* from *obscurus* may also separate *lucasi* from *nanus.* However, these differences are slight, and I believe, judging from the variation in tarsal characters both in *obscurus* and in the California cave material discussed below, that the tarsal elements assigned to *nanus* are within the range of variation of *lucasi.*

Because of the similarity of grouse elements from different species and the great variation within species, it is impossible to disprove the occurrence of two small species of *Dendragapus* in the Fossil Lake beds. Nevertheless, the characters that have been used to differentiate *D. nanus* do not allow it to be separated from either *D. lucasi* or females of *D. obscurus.* I would, therefore, withhold specific recognition from *nanus* and consider it synonymous with its contemporary, *lucasi,* with which it agrees in size and proportions, rather than with the slightly larger and (apparently) more recent *obscurus.*

Dendragapus gilli

This large grouse, which approximated in size females of *Centrocercus urophasianus,* is currently known only from two carpometacarpi (AMNH no. 3474, type; UMMP no. 48223). *D. gilli* differs from *obscurus* and *lucasi* only in size and robustness, but in these characters it is completely separable. As no carpometacarpus of *lucasi* or even of *obscurus* males attains the great size and robustness that appears to characterize *gilli,* the latter must be considered specifically distinct.

The California Caves Population

Remains of Pleistocene *Dendragapus* are abundant from the Samwel and Potter Creek caves of Shasta County, California. Loye Miller, who first reported these fossils (1911: 396-397), assigned most to *D. obscurus,* but suggested that more than one

species might be represented for many bones were of "unusual size" and "great robustness" and differed by "slight detail of the head of the tarsometatarsus." Miller was unable to analyze these fossils, because of a lack of modern skeletal material. (Nearly 60 years later complete skeletons of male *obscurus* are still in too short supply.) In examining this material I detected only one form of *Dendragapus;* there were no demonstrable differences between Samwel and Potter Creek cave specimens. However, this form differed in body size and relative stoutness of the long bones from other *Dendragapus.* A discussion of individual elements follows.

Carpometacarpus. — Except for greater robustness, carpometacarpi of the California cave grouse are indistinguishable from those of *lucasi* or *obscurus;* they are as robust, but not as long, as those of *gilli* (Table 1). The shape of the distal portion of metacarpal III is highly variable and does not, as might be inferred from Figure 2, offer a valid means of distinguishing this form.

Referred material: UCMP nos. 5401, 5621, 8926, 8910a, 9621 (2), 9621a, 9743, 10043, 10160, 10183 (5), 27312 (2), 82977. *Tentatively referred:* UCMP nos. 27322, 27322a.

TABLE 1
MEASUREMENTS OF CARPOMETACARPUS IN *Dendragapus* (IN MM)

Species	*Total length*			*Width metacarpal II*			*Ratio, width metacarpal II to length carpometacarpus × 100*		
	No.	*Range and Mean*	*S.D.*	*No.*	*Range and Mean*	*S.D.*	*No.*	*Range and Mean*	*S.D.*
D. obscurus ♂	7	38.8-42.5 (40.6)	1.6	5	4.1-4.3 (4.2)		5	10.1-10.7 (10.4)	.18
D. obscurus ♀	20	34.3-39.4 (36.7)	1.2	20	3.3-3.9 (3.6)	.18	20	8.8-10.9 (99)	.43
Samwel and Potter Creek cave fossils	15	34.3-40.0 (36.2)	1.7	15	3.7-4.4 (4.0)	.20	15	10.5-11.8 (11.3)	.38
D. lucasi	7	34.3-39.3 (36.9)	1.5	7	3.4-4.0 (3.7)	.23	7	9.9-10.8 (10.2)	.30
D. gilli	2	43.8, 45.1		2	5.2, 5.2		2	11.5, 11.9	
"*D. nanus*"	1	38.5		1	3.8		1	10.0	

Ulna. — The ulnae average slightly longer than those of female *obscurus* and the shafts average approximately five per cent wider (Table 2). Some shafts appear slightly less curved than in *obscurus.*

Referred material: UCMP nos. 3922, 8910a, 8926a (2), 8789, 9528, 9554e, 9556, 9728, 9746, 27312, 27313, 27322, 27322a, 31758. *Tentatively referred:* UCMP nos. 3049, 3608, 9554c (2), 9554d, 10119 (3), 27322a, 31737 (6).

TABLE 2
MEASUREMENTS OF ULNA IN *Dendragapus* (IN MM)

Species	*Total length*			*Proximal width (tip of olecranon to tip of external cotyla)*			*Greatest distal width*		
	No.	*Range and Mean*	*S.D.*	*No.*	*Range and Mean*	*S.D.*	*No.*	*Range and Mean*	*S.D.*
D. obscurus ♂	9	65.5-71.0 (67.6)	1.4	9	12.5-14.0 (13.5)	.46	9	9.6-10.8 (10.1)	.39
D. obscurus ♀	19	57.9-64.8 (61.6)	1.8	20	11.2-12.9 (12.2)	.40	20	8.4-9.4 (9.0)	.31
Samwel and Potter Creek cave fossils	9	59-67 (62.8)	2.4	1	11.8		10	8.8-10.1 (9.1)	.41
D. lucasi (type)	1	63.9		1	11.5		1	8.7	

Table 4

Measurements of Tarsometatarsus in *Dendragapus* (in mm)

Species	*No.*	*Total length* Range and Mean	S.D.	*No.*	*Ratio, least lateral width shaft to total length × 100* Range and Mean	S.D.	*No.*	*Greatest proximal width* Range and Mean	S.D.	*No.*	*Greatest width across trochleae* Range and Mean	S.D.	*No.*	*Least lateral width shaft* Range and Mean	S.D.
D. obscurus ♂	9	43.3-49.3 (45.5)	2.3	9	9.4-11.2 (10.2)	.59	9	10.1-12.4 (11.0)	.69	8	11.2-12.4 (11.8)	.44	9	4.2-5.2 (4.7)	.30
D. obscurus ♀	18	38.1-44.7 (41.7)	1.9	18	8.6-10.9 (9.7)	.67	17	8.9-10.2 (9.6)	.59	18	9.5-11.6 (10.6)	.54	18	3.6-4.4 (4.0)	.24
Samwel and Potter Creek cave fossils	11	36.7-44.3 (41.3)	2.1	12	8.8-11.2 (10.4)	.70	14	9.3-10.8 (9.8)	.19	15	9.6-11.5 (10.7)	.12	32	3.7-5.2 (4.4)	.39
D. lucasi	5	37.8-43.5 (40.1)	1.3	4	9.1-10.5 (9.8)	.58	4	9.0-9.4 (9.2)	.19	4	9.6-10.0 (9.9)	.21	4	3.6-3.9 (3.8)	.17
"D. nanus"	1	38.9		1	9.9		2	9.5, 9.6		1	10.2		2	3.8, 3.9	

Humerus. — Most of the humeri are fragmentary and lengths can be obtained or estimated for only five specimens; only one of these falls beyond the length of *obscurus* females. The humeri appear to have slightly smaller heads and the shafts are slightly straighter distally, averaging approximately eight per cent wider than in *obscurus* (Table 3).

Referred material: UCMP nos. 4096, 4275, 4281, 5287, 5491, 5285, 6774, 6921, 6961, 6962, 8053, 8324, 8910, 9514, 9554a, 9646, 9712, 10147, 10160, 10183, 27312 (2), 27314, 27315 (2), 27342 (3), 27325, 31722.

TABLE 3
MEASUREMENTS OF HUMERUS IN *Dendragapus* (IN MM)

Species	*Total length*			*Greatest distal width*		
	No.	*Range and Mean*	S.D.	*No.*	*Range and Mean*	S.D.
D. obscurus ♂	14	69.7-75.0 (72.4)	2.1	14	14.4-15.7 (15.8)	.59
D. obscurus ♀	24	61.8-69.5 (65.1)	1.9	25	12.6-14.6 (13.6)	.48
Samwel and Potter Creek cave fossils	5	62.8, 63.5, 64*, 68*, 72.3		7	11.4-14.0 (13.5)	
D. lucasi	1	66.6		1	13.6	

*estimated lengths

Tarsometatarsus. — Tarsometatarsi are similar to those of *lucasi* and of *obscurus* females, but the shafts are noticeably wider (Table 4, Fig. 2). In all other respects including the shape of the head (cf. Miller, 1911: 397), they are within the range of variation of *obscurus*. Compared with *lucasi,* the trochleae are much more robust, the metatarsal facet is less well defined, the depression below the internal cotyla on the posterior face is deeper, and the ridge bordering this depression is more pronounced.

Referred material: UCMP nos. 3580, 4624, 5798, 8505, 8923a, 9554, 9554a, 9634, 9644, 9674, 9729, 9740, 9784, 9790, 9803, 9828, 10183a, 27313, 27323, 27324a, 27324b, 27325a, 31718, 31722, 37662, 37663, 37664, 37665, 37666, 37667, 37668. *Tentatively referred:* UCMP nos. 5501, 7430, 10183.

Tibiotarsus. — The fragmentary nature of most of the tibiotarsi makes detailed analysis impossible. Two nearly complete elements (length estimated) are longer than those of female *D. obscurus*. Shaft widths are approximately five to ten per cent greater than in *obscurus* elements of comparable length; the distal width is also greater (Table 5).

Referred material: UCMP nos. 8873, 8926a, 9554a, 27322, 27323, 27323a, 27323b, 31716, 31722, 31757.

TABLE 5
MEASUREMENTS OF TIBIOTARSUS IN *Dendragapus* (IN MM)

Species	*Total length*			*Lateral width across trochleae*		
	No.	*Range and Mean*	S.D.	*No.*	*Range and Mean*	S.D.
D. obscurus ♂	12	89.0-97.8 (92.8)	2.6	12	9.7-10.9 (10.0)	.42
D. obscurus ♀	19	78.4-89.2 (84.3)	2.9	17	8.7-10.0 (9.3)	.45
Samwel and Potter Creek cave fossils	5	81.5*, 83.5*, 84*, 91.5*, 91.5*		4	9.9-10.9 (10.4)	

*estimated lengths

Femur. — None of the five femora (UCMP nos. 9554a, 9607, 9710, 9714, 27314) examined are complete, but it is clear that all are within the size range of female

obscurus; shafts average approximately ten per cent wider than in similarly sized *obscurus* (Table 6).

Table 6
Measurements of Femur in *Dendragapus* (in mm)

Species	Total length			Greatest distal width		
	No.	Range and Mean	S.D.	No.	Range and Mean	S.D.
D. obscurus ♂	12	73.8-79.4 (75.6)	2.1	12	13.7-15.5 (14.2)	.65
D. obscurus ♀	22	65.1-71.3 (67.5)	1.9	22	11.6-13.0 (12.3)	.51
Samwel and Potter Creek cave fossils	2	65.5*, 69.0*		1	12.0	
D. lucasi	1	68*				

*estimated lengths

Coracoid. — As far as can be determined, the coracoids fall within the length range for female *obscurus*. Some are wider, but there is not enough material for critical comparison. I have found no method of distinguishing these coracoids from those of *lucasi* or *obscurus*.

Referred material: UCMP nos. 3180, 5836, 7042, 7428, 8926a, 9674, 10160, 31713, 31722, 31759.

Table 7
Measurements of Coracoid in *Dendragapus* (in mm)

Species	No.	Length from head to tip of sternal facet Range and Mean	S.D.
D. obscurus ♂	13	53.6-59.0 (56.9)	2.5
D. obscurus ♀	26	47.4-54.8 (50.2)	1.9
Samwel and Potter Creek cave fossils	4	48.5*, 49.6, 50.9*, 51.5*	
D. lucasi	2	52.7, 52.9	

*estimated lengths

Other elements: Two cervical vertebrae (UCMP nos. 9521, 10183), three fragments of synsacrum (UCMP nos. 9633, 9674, 9696) and one furculum (UCMP no. 8926a) are similar to those of *obscurus* and are probably referable to this population.

Discussion. — The California cave population was similar to *D. lucasi* in size but differed in greater stoutness of the long bones. Smaller than *D. gilli*, it closely resembled that form in robustness. Compared with the extant *D. obscurus,* the cave grouse was slightly smaller, nearly all elements falling within the size range of *obscurus* females, but the long bones averaged five to ten per cent more robust.

In interpreting these cave deposits the possibility of biased sampling must be considered. If predators responsible for amassing these remains were unable to carry large grouse, the resulting deposits would be composed largely of the much smaller females and much of the variation in the fossil population would be obscured. However, many of the bird and mammal predators known from these deposits (Miller, 1911; Furlong, 1906) could have carried larger birds with ease. I conclude that the differences ascribed to the cave remains are valid and, therefore, that this population is worthy of taxonomic recognition.

The affinities of this population are not obvious. Although some individual bones cannot be distinguished from those of *obscurus,* the California fossil population averaged much stouter than *obscurus*. I detect no geographic variation in robustness in races of

obscurus, and in other grouse that I have examined robustness of the long bones appears to be a conservative character. For these reasons I infer that the cave grouse probably was most closely related to the similarly robust though much larger *D. gilli*. Even if this inference is correct, the nature of the relationship between these forms can only be surmised, owing to a lack of *gilli* material. The cave form could have been specifically distinct, but it is hard to believe that *three* species of *Dendragapus* occupied so small an area of the west only a few thousand years before the first appearance of *obscurus*. It seems most reasonable to treat this population as a smaller, probably contemporaneous, southern subspecies of *gilli*. I name this population *Dendragapus gilli milleri* in honor of Dr. Loye Holmes Miller, who first called attention to these fossils. The Oregon population thus becomes the nominate race, *D. g. gilli*.

Figure 2. Left to right, carpometacarpi of *Dendragapus lucasi* (AMNH no. 3478A), *Dendragapus obscurus* (UMMZ 74758), *Dendragapus gilli milleri* (UCMP no. 82977); tarsometatarsi of *Dendragapus lucasi* (AMNH no. 3475A) *Dendragapus obscurus* (UMMZ no. 208192), *Dendragapus gilli milleri* (UCMP no. 9823). All illustrations X 1.

Dendragapus gilli milleri new subspecies

Holotype. — Left carpometacarpus, lacking metacarpal III and exhibiting slight wear on distal end. University of California Museum of Paleontology no. 82977 (Fig. 2).

Age and locality. — Late Pleistocene deposits of Samwel Cave, Shasta County, California.

Diagnosis of holotype. — Similar in robustness to carpometacarpi of *D. g. gilli* but approximately 18 per cent shorter; similar in size to carpometacarpi of *D. lucasi* and *D. obscurus* but 10 per cent more robust.

Measurement of holotype. — Total length 38.7 mm; width of metacarpal II at midpoint 4.3 mm; depth of proximal end through process of metacarpal I and internal crest of trochlea 12.4 mm; ratio, width of metacarpal II at midpoint to total length 11.2 per cent.

Referred material. — As discussed above (pp. 169-172).

SYNTHESIS

In the late Pleistocene two species of *Dendragapus* inhabited a small area of the western United States. *Dendragapus lucasi* and *D. g. gilli* occurred sympatrically in southern Oregon; a smaller subspecies of *gilli*, *D. g. milleri*, occurred in northern California. The relationships of these Pleistocene grouse to the extant *D. obscurus* are not clear. If robustness of the long bones is a conservative character, as I have suggested, *lucasi* would appear to be the most likely ancestor for *obscurus*. *D. gilli* may have be-

come extinct at the end of the Pleistocene, leaving no descendants, but this is far from certain. If "*Dendragapus obscurus*" can be shown to comprise two species (see Friedmann, 1946: 68), *gilli* may have been ancestral to one, *lucasi* to the other. In that event, the problems associated with matching ancestral and descendant populations will be extremely difficult. Until more information is available regarding the distribution and variation in the fossil populations, evolutionary rates, the significance of the differences that characterize the several populations, the temporal relationships of the Pleistocene forms, as well as taxonomic relationships within *D. obscurus*, further speculation on relationship in this genus is best postponed.

Acknowledgments

The late R. A. Stirton, University of California Museum of Paleontology, kindly made the Samwel Cave and Potter Creek Cave material available to me. E. H. Colbert, American Museum of Natural History, loaned specimens of *D. lucasi* and "*D. nanus*," and allowed me to examine type material in his care. Skeletons of *D. obscurus* were obtained through: N. K. Johnson and the late A. H. Miller, University of California; O. M. Buchanan and T. R. Howell, University of California at Los Angeles; R. F. Johnston, the University of Kansas; K. E. Stager, Los Angeles County Museum; and H. G. Lumsden. I am indebted to C. W. Hibbard for advice and assistance throughout this study, to H. B. Tordoff, R. W. Storer, and R. M. Mengel for commenting on an earlier draft of the manuscript, and especially to Hildegarde Howard for her careful and helpful editorial assistance.

Literature Cited

Allison, I. S.
1966. Fossil Lake, Oregon, its geology and fossil faunas. Oregon State University Press. 48 p.

American Ornithologists' Union
1957. Check-list of North American Birds, 5th ed. Lord Baltimore Press, Baltimore, Md.

Brodkorb, P.
1964. Catalogue of fossil birds: Part 2 (Anseriformes through Galliformes). Bull. Florida State Mus. 8(3): 195-335.

Friedmann, H.
1946. The Birds of North and Middle America. U. S. Natl. Mus. Bull. 50, Part X. U. S. Govt. Printing Office, Washington, D.C.

Furlong, E. L.
1906. The exploration of Samwel Cave. Amer. J. Sci. 22: 235-247.

Howard, H.
1946. A review of the Pleistocene birds of Fossil Lake, Oregon. Carnegie Inst. Wash. Publ. 551. pp. 141-195.

Jehl, J. R., Jr.
1967. Birds from Fossil Lake, Oregon. Condor 69: 24-27.

Miller, L. H.
1911. Avifauna of the Pleistocene cave deposits of California. Univ. Calif. Publ. Geol. 6: 385-400.
1960. Some Indian midden birds from the Puget Sound area. Wilson Bull. 72: 392-397.
1963. Birds and Indians in the west. Bull. S. Calif. Acad. Sci. 62: 178-191.

Peters, J. L.
1934. Check-list of birds of the world. Vol. 2. Cambridge, Harvard University Press, 401 p.

Short, L. L., Jr.
1967. A review of the genera of grouse (Aves, Tetraoninae). Amer. Mus. Novitates no. 2289, 39 p.

Shufeldt, R. W.
1892. A study of the fossil avifauna of the *Equus* beds of the Oregon Desert. J. Acad. Nat. Sci. Philadelphia 9: 389-425.

Wetmore, A.
1962. Notes on fossil and subfossil birds. Smiths. Misc. Coll. 145(2): 1-17.

Accepted for Publication 13 January 1969

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A BIOLOGICAL SURVEY OF BAHÍA DE LOS ANGELES GULF OF CALIFORNIA, MEXICO, IV. BENTHIC AMPHIPODA (CRUSTACEA)

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OF THE SAN DIEGO
SOCIETY OF
NATURAL HISTORY

VOL. 15, NO. 13, 27 JUNE 1969

The series on Bahía de los Angeles has been published, in part, through the generosity of Richard F. Dwyer. Much of the research on which it is based was conducted at the Vermilion Sea Field Station of the San Diego Natural History Museum, which is supported by the National Science Foundation.

A BIOLOGICAL SURVEY OF BAHÍA DE LOS ANGELES, GULF OF CALIFORNIA, MEXICO. IV. BENTHIC AMPHIPODA (CRUSTACEA).

J. Laurens Barnard

Abstract. — The gammaridean fauna of a bay in the disjunct, warm-temperate zone of the Gulf of California is discussed. Of the 70 species encountered, 13 represent new species and 5 new subspecies. Two new genera are proposed. In 1962 and 1963 a sharp decline in diversity and abundance occurred in autumn in depths between 6 and 46 m. The diversity of Gammaridea is about half that of similar depths in southern California. Approximately 70 per cent of the amphipods have warm-temperate affinities; at least 9 cognates of Californian species occur in BLA. Shallow, sandy bottoms, in 2-8 m depth, are dominated by *Ericthonius brasiliensis* and *Podocerus fulanus;* mid-depths of 7-36 m on fine sands by *Ampelisca compressa, A. cristata* and *Platyischnopus metagracilis;* and the deepest zone, 37-46 m on brown silts, by *Heterophoxus oculatus, Ampelisca cristata* and *A. compressa.* None of the dominant species is endemic, but in the Californian warm-temperate zone *Podocerus fulanus* is confined to lagoons.

Resumen.— Se estudian los Anfípodos Gammáridos de una bahía situada en la zona limítrofe de la región cálido-templada del Golfo de California. Se describen setenta especies, de las cuales 13 son especies nuevas y además 5 nuevas subespecies. La bahía está bajo la influencia del conocida fenómeno del efecto del verano en la densidad faunística, de modo que ésta es pobre en relación con la que presenta el mar abierto. Un 70% de los Anfípodos, aproximadamente, presentan afinidades con los de las regiones cálido-templadas; por lo menos 9 especies son cognatos a las que aparecen en regiones cálido-templadas; todo lo cual indica en cierto modo, el aislamiento de esta fauna de sus fuentes originales.

Las regiones poco profundas (de 2 a 8 metros de profundidad) con fondos arenosos, están dominadas por *Ericthonius brasiliensis* y *Podocerus fulanus;* las zonas de profundidad media (de 7 a 36 m) sobre arena fina, aparecen pobladas por *Ampelisca cristata, A. compressa y Platyischnopus metagracilis;* mientras que las zonas profundas (de 36 a 46 m) con fondos de fango marrón, están habitadas por *Heterophoxus oculatus, Ampelisca cristata y A. compressa.* Ninguna de las especies dominantes refleja una dislocación de la fauna al hacerse endémicas; a excepción de *Podocerus fulanus* que puede funcionar en mar abierto como una reliquia confinada a las pequeñas lagunas litorales.

This paper describes the gammaridean fauna of a small bay, Bahía de los Angeles, on the east shore of Baja California, in the northwestern part of the Gulf of California. Amphipoda from the gulf have been recorded previously by Shoemaker (1925). Bahía de los Angeles is presumably within the disjunct, warm-temperate, upper gulf region discussed by Beltran (1960) in the "Symposium: The biogeography of Baja California and Adjacent Seas." Collection of this fauna was undertaken as part of a survey to assess the simple mud and sand-bottom communities and the general environment of that bay. Barnard and Grady (1968) have outlined the thermal regime, water characteristics, and benthic sedimentary structure of the bay and have reported on the phenomenon of "summer-kill" as a dominating influence on the warm-temperate fauna in 1962 and 1963.

The amphipodan fauna of Bahía de los Angeles is impoverished, in terms of both species and abundance of individuals, in comparison with southern California, the only other quantatively studied region of the eastern Pacific Ocean.

Approximately 70 per cent of the Amphipoda have warm-temperate affinities, and at least 9 cognates of warm-temperate species occur in Bahía de los Angeles (BLA).

The fauna lacks numerous species that overlap this latitude in the open part of the Pacific Ocean. The diversity of Amphipoda is appproximately half that of similar depths in southern California.

The fauna, which is seriously depleted during high temperatures of late summer (25 C), may also be affected by redtide (Barnard and Grady, 1968). Repopulation of the bay during winter thermal minima (ca. 15 C) apparently occurs rapidly from depths exceeding 50 m; post-winter samples contain a dense fauna of polychaetes, Amphipoda, and small mollusks, especially clams. Windrows of dead clam shells, in adult stages, occur on sand beaches in the southwestern part of the bay. These suggest that mass mortalities in summer occur sporadically rather than annually.

The Amphipod Fauna

Seventy species of gammaridean Amphipoda, including 2 new genera, 13 new species and 5 new subspecies, have been identified from Bahía de los Angeles. Nearly 20 additional species are recorded in fragmented and juvenile materials (Table 1). Twenty-seven of the 70 identified species dwell primarily on soft bottoms, 33 inhabit hard bottoms and 10 occur in both habitats.

In April, 1962, Amphipoda, as well as Mollusca, Polychaeta, and small Decapoda were conspicuous in the samples. During the resurvey in October-November 1963 the entire fauna was so poorly represented in the first few samples that we believed the orange-peel grab was malfunctioning. Numerous adjustments were made; control samples taken with a Van-Veen grab confirmed the sparseness of the benthic fauna.

The diversity of soft-bottom (infaunal) species in Bahía de los Angeles is far less than on the coastal shelf of southern California even though the diversity of sediments is similar. In depths of 2-55 m in southern California 136 (infaunal) species have been recorded (see Table 9 of Barnard, 1966, subtracting 29 deep-water species from the total of 165). Nevertheless, the abundance of individuals (2000 per s.q m*) in April at Bahía de los Angeles equals or slightly exceeds that found at various depths in southern California, but it is very low compared with parts of Bahía de San Quintín (J. L. Barnard, 1964b) where certain biotopes have more than 20,000 individuals /m^2. In Bahía de los Angeles the greatest abundance (4569 individuals /m^2) occurs in depths of 2-6 m, whereas in depths between 7 and 46 m the abundance drops to between 75 and 208 individuals /m^2 (Table 2).

A sharp decline in abundance of all but three of 20 dominant soft-bottom gammarideans occurred between April 1962 and November 1963 (Table 1, species marked with "S" and having 10+ specimens in April samples). The decline in frequency is generally of one order of magnitude but no appreciable decline occurred in *Rudilemboides stenopropodus* and a slight to moderate decline occurred in *Heterophoxus oculatus* and *Microdeutopus schmitti*. Six species were completely absent from samples in November, 1963. Whether an autumnal decline (1962) and winter refurbishment (1963) occurred are unknown. Four of the six species missing in November are eurybathic (Barnard, 1966) and presumably could repopulate shallow water depths from deep water sources. Autumnal impoverishment occurred in depths of 40-46 m as strongly as it did in depths of 21-30 m as seen in the following tabulation in which 19 samples were selected from each depth in each season, indicating total specimens of Gammaridea collected in each category.

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* computed from 8775 individuals occurring in 70 samples representing about 4.38 m^2; see Table 1 for April samples. The orange-peel grab collects an area of about 0.06 m^2.

TABLE 1

ALPHABETICAL LIST OF GAMMARIDEA OCCURRING IN BAHIA DE LOS ANGELES.

ASTERISKS SIGNIFY SPECIES WITH COGNATES IN WARM-TEMPERATE OF SOUTHERN CALIFORNIA. AFFINITIES AND DISTRIBUTION ARE SUMMARIZED BY THE LETTERS E, EURYLATITUDINAL; T, TROPICAL; WT, WARM-TEMPERATE; U, UNKNOWN. THE LETTER S IN COLUMN 2 REFERS TO THOSE SPECIES CONSIDERED TO BE CONFINED TO SOFT-BOTTOMS.

		SOFT BOTTOMS April, 1962		SOFT BOTTOMS October, 1963		HARD BOTTOMS Intertidal & Scuba		
	Affinity or Distribution	*Samples* (70)	*Specimens*	*Samples* (91)	*Specimens*	*Inshore dredges* +=*present* #=*abundant*	*Samples*	*Specimens*
**Acuminodeutopus periculosus*	WT	6S	72	6	19		1	3
Ampelisca compressa	E	49S	607	19	40		1	1
Ampelisca cristata	E	68S	2014	47	191		1	1
Ampelisca lobata	E						2	6
Ampelisca mexicana	T	12S	16	1	1			
Ampelisca milleri	E						1	1
Ampelisca schellenbergi	T						1	2
Amphideutopus oculatus	WT	12S	34			+	1	2
Amphilochus neapolitanus	E						1	9
Ampithoe plumulosa	E						1	38
Ampithoe pollex	E						8	591
Ampithoe ramondi	T						3	14
Ampithoe tea	WT	1	3				4	20
Argissa hamatipes	E						1	1
Batea rectangulata	T	13S	87	5	22	+	2	9
Batea susurrator	T	4S	506			+		
**Batea transversa coyoa*	T	1S	10	1	4	+	2	4
Carinobatea conductor	T						1	9
Corophium baconi	E	2S	33			++	4	75
Corophium uenoi	WT						2	136
Elasmopus rapax	E						12	572
Ericthonius brasiliensis	E	14S	2870	3	7	++	11	451
Eurystheus thompsoni	T						1	8

TABLE 1 (cont.)

		SOFT BOTTOMS April, 1962		SOFT BOTTOMS October, 1963		HARD BOTTOMS Intertidal & Scuba		
	Affinity or Distribution	*Samples* (70)	*Specimens*	*Samples* (91)	*Specimens*	*Inshore dredges* +=*present* #=*abundant*	*Samples*	*Specimens*
**Eurystheus tonichi*	WT	2	3			++	2	9
**Garosyrrhoe disjuncta*	WT	1	1			+	2	19
Gitanopsis pusilloides	T	2	2	1	2	++	2	100+
Heterophlias seclusus escabrosa	T						1	1
Heterophoxus oculatus	E	22S	287	30	133		1	1
Hippomedon ?propinquus	WT	2S	2	1	1			
Hyale rubra frequens	WT	1	10				7	205
Jassa falcata	E			2	2			
Lembos macromanus	T	1	1			+	4	20+
Leucothoe alata	WT						1	8
**Liljeborgia marcinabrio*	WT	1S	1					
**Listriella melanica lazaris*	WT	38S	141	13	19	+	1	1
Lysianassa dissimilis	E						1	1
Lysianassa macromerus	WT						1	1
Maera inaequipes	T						3	15
**Megaluropus longimerus falciformis*	WT						1	14
Megaluropus risendus	T	2	2	1	2			
Melita sulca	WT					+	3	8
Meximaera diffidentia	T						2	4
Microdeutopus schmitti	WT	15S	95	7	65	++	7	119
Microjassa macrocoxa	T	5	41			++	2	112
Monoculodes hartmanae	WT	38S	162	10	14		2	4
Neomegamphopus roosevelti	T						3	13
Orchomene magdalenensis	WT	3S	6	2	2		1	1
Pachynus barnardi	WT	4S	4					
Paraphoxus cognatus	WT	S		2	2			
Paraphoxus epistomus	E	S		1	5			
**Paraphoxus gemmatus*	WT	1S	1	1	4	+	1	2
Paraphoxus spinosus	E						4	9

Paraphoxus tridentatus	WT	S		2	9			
Parapleustes commensalis	U						1	1
Photis bifurcata	WT	4S	5					
Photis brevipes	WT	4S	163			++	1	7
Photis californica	WT	7S	55					
Platyischnopus metagracilis	T	64S	563	39	105			
Platyischnopus viscana	T	S					1	3
Podocerus brasiliensis	T						5	60
Podocerus fulanus	WT	5S	860			++	7	315
Polycheria osborni	E						1	43
**Pontogeneia nasa*	WT						4	333
Rhachotropis luculenta	WT	4S	4					
Rildardanus tros	U					5		
Rudilemboides stenopropodus	WT	8S	75	6	77	+	3	75
Synchelidium sp. G	WT	3S	5					
Synchelidium rectipalmum	E	1S	2				2	15
Uristes entalladurus	WT	1S	1					
**Westwoodilla cornuta*	WT	14S	20	3	3			
Unidentified Species								
Acanthonotozomatid		1	1					
Amphithoe sp. juveniles							4	25
Batea sp.		1	3					
Carinobatea sp.							1	1
Isaeid (aorid facies)		1	1					
Isaeid (probable new genus)		1	4					
Isaeid							1	3
Lembos sp. (cf. *audbettius* Barnard, 1962a)							3	4
Lysianassid		1	1					
Macra sp. (cf. *simile* Stout)							1	1
Oediceroid							1	3
Photis spp., juveniles		12	36					
Pleustes sp.							1	1
Stenothoid A							2	6
Stenothoid B							2	6
Talitrid						1		
Unknown Family		1	1					

TABLE 2

DOMINANT AMPHIPODA TAKEN IN SEVERAL DEPTH CLASSES DURING APRIL, 1962, SURVEY OF MUD BOTTOMS IN BAHIA DE LOS ANGELES, INDICATING NUMBER OF INDIVIDUALS PER SQUARE METER.

	Depth class, m				
	2-6	7-16	17-26	27-36	37-46
No. samples	3	13	17	24	13
No. dominant species, total	11	6	6	6	5
Species, total	15	14	20	22	18
Individuals/m^2, total	4569	75	208	109	173
Acuminodeutopus periculosus	106				
Ampelisca compressa		5	7	7	17
Ampelisca cristata		14	36	28	21
Batea rectangulata	32	5			
Batea susurrator			28		
Corophium baconi	58				
Ericthonius brasiliensis	2500				
Gitanopsis pusilloides	21				
Heterophoxus oculatus				1	22
Listriella melanica lazaris	111				
Microdeutopus schmitti	100				
Microjassa macrocoxa	53				
Monoculodes hartmanae		5	3	1	
Orchomene magdalenensis	53				
Photis brevipes		4		3	
Photis californica					4
Platyischnopus metagracilis		4	8	8	7
Podocerus fulanus	1390		4		
Rudilemboides stenopropodus	106				

Depth	April, 1962	November, 1963
21-30 m	855	97
40-46 m	1104	128

Six species of Amphipoda dominate the benthos of BLA: *Ericthonius brasiliensis, Podocerus fulanus, Ampelisca cristata, Platyischnopus metagracilis, Ampelisca compressa, and Heterophoxus oculatus.*

The shallow sandy bottoms from about 2 to 8 m are dominated by *Ericthonius brasiliensis* and *Podocerus fulanus* (Table 2). These species are tube-dwellers; presumably they attach to hard particles and in patches of red algae occurring on those bottoms. Seven other species occurring in these depths (Table 2) are more abundant than any species found in depths greater than 6 m. This density pattern differs from that found off the coast of southern California, where Amphipoda are relatively sparse on inshore sand bottoms but are abundant in depths exceeding 6 m (Barnard, 1963).

The 6 m depth-class in BLA and the 9 m depth-class in southern California are quite different (Tables 2, 3; *cf.* Barnard, 1963: Table 16) In southern California, *Ericthonius brasiliensis* is 29th in abundance. Its primary position in BLA may reflect: 1) the more abundant algae in the quieter waters that act to shelter masses of tubes from disruption by surf action; and 2) the absence of competitors resulting from extreme eurythermic conditions. *Ericthonius brasiliensis* is a eurythermic species that is cosmopolitan in tropical, warm-temperate, and even in some cold-temperate areas *(viz.* Norway; Puget Sound, Washington). Whereas *Ericthonius brasiliensis* is able to adjust

to wide seasonal extremes in temperature, *Podocerus cristatus* of the open Pacific may not endure short-term fluctuations even though it adjusts to wide extremes in increments by latitude. This possibility is suggested by the dominance of *Podocerus fulanus* in Bahía de los Angeles and in lagoons of southern California wherein *P. cristatus* is absent.

In the 16 m depth-class, the frequency of Amphipoda is lowest (75 m^2). This corresponds to southern California where standing-crop and density of organisms are lowest seaward of the surf zone but increase sharply on softer bottoms of deeper waters. The mid-depth zones, generally 7 to 36 m in BLA, are dominated by *Ampelisca cristata*. *Platyischnopus metagracilis* and *Ampelisca compressa* are also fairly common in the 26 and 36 m depth zones, but the only other species that can be considered dominant

TABLE 3

DOMINANT AMPHIPODA TAKEN IN SEVERAL DEPTH CLASSES BETWEEN 1957 AND 1961 ON COASTAL SHELF OF SOUTHERN CALIFORNIA, BASED ON 161 SAMPLES PROPORTIONALLY DIVIDED ACCORDING TO RESPECTIVE DEPTH CLASSES; COLLECTED BY "VELERO IV," UNIVERSITY OF SOUTHERN CALIFORNIA; INDICATING NUMBER OF INDIVIDUALS PER SQUARE METER. EACH COLUMN INCLUDES ONLY THE FIRST 20 DOMINANT SPECIES RANKED BY INDIVIDUALS PER SQUARE METER IN THAT DEPTH CLASS AND A SPECIES IS NOT NECESSARILY ABSENT FROM DEPTH CLASSES LACKING NUMBERS. A PHYLETIC OR ECOLOGIC EQUIVALENT OCCURRING IN BAHIA DE LOS ANGELES IS NOTED. + MARKS THOSE SPECIES ALSO OCCURRING IN BAHIA DE LOS ANGELES.

	Depth class, m			
Species	4-9	10-18	19-37	*Occurrence in BLA*
Acuminodeutopus heteruropus		47	9.1	*A. periculosus*
Amphideutopus oculatus		11	48	+
Ampelisca brevisimulata		22	64	*A. mexicana*
Ampelisca compressa	9.2	27	14	+
Ampelisca cristata	1.0	27	63	+
Ampelisca lobata		21		+
Ampithoe sp.	4.4			+
Aoroides columbiae	7.5	29	26	
Argissa hamatipes		12	8.9	+
Batea transversa	4.1	12		+
Eohaustorius washingtonianus	9.5			
Ericthonius brasiliensis	0.5	11		
Eurystheus thompsoni		21	9.0	*E. tonichi*
Heterophoxus oculatus			26	+
Ischyrocerus pelagops	3.0	12		*Microjassa macrocoxa*
Listriella goleta			37	*L. m. lazaris*
Mandibulophoxus uncirostratus	30			*Platyischnopus metagracilis*
Megaluropus longimerus	2.3			+
Monoculodes hartmanae	4.9			+
Paraphoxus abronius	9.7	95	10	*P. cognatus*
Paraphoxus bicuspidatus	25		11	
Paraphoxus epistomus	55	16	27	+
Paraphoxus fatigans		11	15	
Paraphoxus heterocuspidatus	3.8		7.3	*P. gemmatus*
Paraphoxus obtusidens		15	36	*P. spinosus*
Paraphoxus stenodes		40	19	
Paraphoxus variatus	4.1	20	7.7	
Photis brevipes		30	36	+
Photis lacia	25			*P. californica*
Synchelidium shoemakeri		17		*Synchelidium* spp.
Synchelidium spp.	31			*Synchelidium* spp.

is the nestler *Batea susurrator* at 26 m (Table 2). The species of *Ampelisca* are tube builders, but their soft tubes are anchored in the substrate and lie limply on the surface. Like all members of the Phoxocephalidae, *Platyischnopus* is presumed to be a burrower and in this capacity it represents a poor substitute for the dense populations of *Paraphoxus* (16 species) found off southern California. In depths exceeding 36 meters the species of *Ampelisca* and *Platyischnopus* maintain dominance but they are joined by another burrower, *Heterophoxus oculatus* (Table 2), a eurybathic organism, which is also prominent on coastal shelves of the open sea and on the coastal slope to depths of almost 2000 m. Note that *Platyischnopus* is scarcely more abundant than *Photis*, but it is more widespread and occurs in nearly every sample between 7 and 46 m, whereas *Photis* occurs abundantly in only a few.

The inshore sands of California in depths of 4-9 m are dominated by *Paraphoxus*, *Synchelidium*, *Mandibulophoxus* (a morphological parallel to the deeper-dwelling *Platyischnopus* of BLA), and *Eohaustorius;* the abundance of these burrowing forms, rather than of infaunal tube-dwelling species of *Ampelisca*, may reflect the strong water motion and shifting substrate of the region. However, tubicolous genera, such as *Photis*, that attach their tubes to structures projecting above sediment level, are as abundant as some of the species of burrowers. There is some weak evidence (Barnard, 1958b) that tubicolous species inhabiting hard particles are far less obligated to remain in their tubes than are the infaunal ampeliscids and can move from place to place as their epibenthic substrates are shifted. They appear to be able to occupy tubes of other organisms without necessarily constructing their own. Even though the sampling efforts (complemented by dredgings in BLA) have been comparable, the diversity of the shallow-water BLA fauna is half that of southern California (23 vs 46 species; Table 1 and Barnard, 1963, Table 16), which suggests that the quiet-water environment BLA is even harsher than the shifting substrate of open-sea shallows.

Of the medium-depth fauna, three of the six common species of BLA are also abundant in southern California: *Ampelisca cristata*, *A. compressa*, and *Photis brevipes*. The ecological counterparts in southern California of *Platyischnopus* and *Monoculodes*

TABLE 4
SUBSTRATE DISTRIBUTION OF 4 SPECIES OF GAMMARIDEA IN BLA

Species	*Substrate*	*Percent of Specimens*	*Average per Sample*	*Number per Positive Sample*
Ampelisca compressa	Silt	28	8.9	19.0
	Sandy silt	40	14.0	15.0
	Silty sand	23	7.3	12.0
	Sand	9	3.4	4.6
Ampelisca cristata	Silt	22	23.0	24.0
	Sandy silt	38	45.0	45.0
	Silty sand	27	29.0	34.0
	Sand	13	16.0	15.0
Listriella melanica lazaris	Silt	6	0.4	1.6
	Sandy silt	12	1.0	2.4
	Silty sand	20	1.4	2.1
	Sand	62	5.2	6.5
Platyischnopus metagracilis	Silt	28	8.5	8.5
	Sandy silt	29	10.0	10.0
	Silty sand	25	7.5	9.3
	Sand	18	6.7	8.2

are probably *Paraphoxus* and *Synchelidium* but the mainland coastal shelf of California has no obvious counterpart of *Batea*. *Batea* occurs abundantly only in the Channel Islands of California and joins *Platyischnopus* in a few square miles of benthos off San Diego. Two species of *Synchelidium* also occur in BLA but their occurrence is very sparse.

Of the deep-water fauna, four of the nine BLA species are also prevalent in southern California: *Ampelisca cristata*, *A. compressa*, *Photis brevipes*, and *Heterophoxus oculatus*.

Of the 27 most abundant species of southern California in depths similar to those sampled at BLA, only 6 species or their allopatric equivalents are absent from BLA; most of these are members of *Paraphoxus*. However, many other southern California species are also absent from BLA, especially notable being a host of ampeliscids (Table 9 of Barnard, 1966). Northern species having their southern limits in southern California should be omitted from consideration. This may be determined in Barnard (1966, Table 9).

The distributions of the 6 dominant species at BLA in April are presented in Figures 1-6.

Impoverishment of the Fauna

The gammaridean fauna on soft-bottoms in BLA is far less diverse than the fauna of the coastal shelf of southern California. The pertinent members (33) of the BLA fauna are marked in Table 1 and the 102 members of the southern California fauna have been extracted from Barnard (1966, Table 9) by eliminating deep-water species, rarely occurring members, and those known from the literature to inhabit hard bottoms primarily. Gammaridean genera for the most part inhabit either soft or hard bottoms but occasional genera such as *Ampelisca* and *Paraphoxus* have members in both habitats. These differences have been taken into account in the two faunas under consideration.

The soft-bottom Gammaridea of BLA represent 23 genera whereas the Gammaridea of warm-temperate California represent 58 genera.

The two most diverse benthic genera in midlatitudes are *Ampelisca* and *Paraphoxus*. In BLA *Ampelisca* has 3 species on soft bottoms but in southern California it has 8. In BLA *Paraphoxus* has 4 species on soft bottoms but in southern California it has 16.

Only 5 soft-bottom species of BLA (3 of *Batea* and 2 of *Platyischnopus*) have no counterparts in the dominant fauna of soft-bottoms of mainland southern California.

Seventy-four species of the California fauna have not been found on soft-bottoms of BLA, although 5 have been found sparsely on hard-bottoms. The remaining 69 species of southern California are not necessarily stenothermic as might be expected from their absence in BLA. Thirty-seven of those species have depth ranges (by arbitrary classes) from 18 to 183 m and 12 others have ranges between 18 and 55 m (Barnard, 1966, Table 9). They are therefore potentially eurythermic but their absence in BLA may reflect the inability of a deme to undergo wide thermal changes annually.

There are some striking omissions from the BLA fauna of eurylatitudinal and tropical species, for example: (1) *Paraphoxus floridanus*, a tropical pan-American species, with northern limits at the Mexico-California border; (2) *Paraphoxus obtusidens*, known from the Kurile Islands to Colombia, South America; (3) *Ampelisca venetiensis*, known from southern California to Ecuador; (4) *Ampelisca cristoides*, known from the open Gulf of California even as close as Angel de la Guarda Island; (5) *Ampelisca pacifica*, California to Panama, perhaps submerging deeply in tropical waters; (6) *Ampelisca brevisimulata*, from California to Panamá, in tropical depths of 9 m;

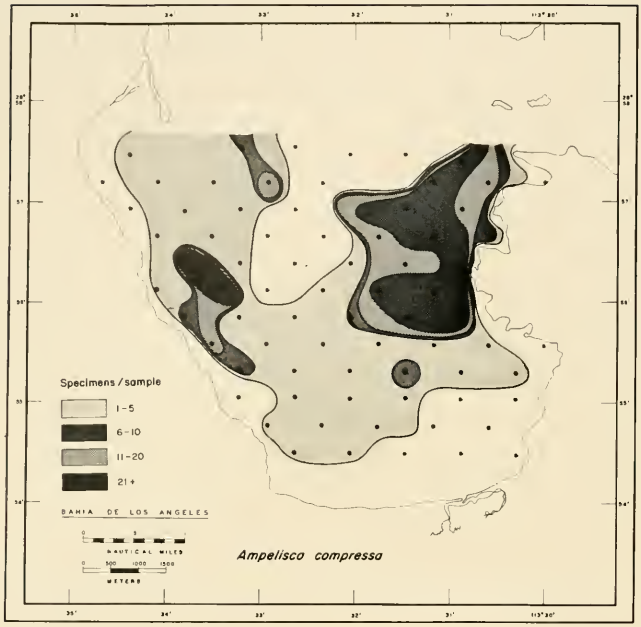

Figure 1. Distribution of *Ampelisca compressa* Holmes.

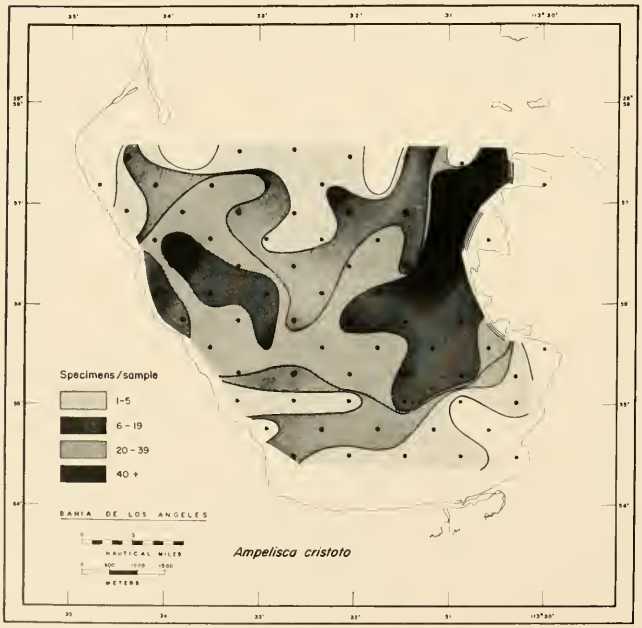

Figure 2. Distribution of *Ampelisca cristata* Holmes.

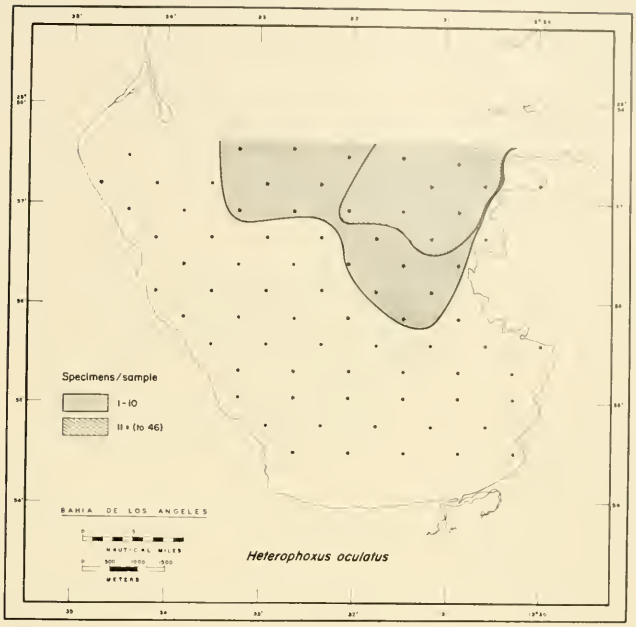

Figure 3. Distribution of *Heterophoxus oculatus* Holmes.

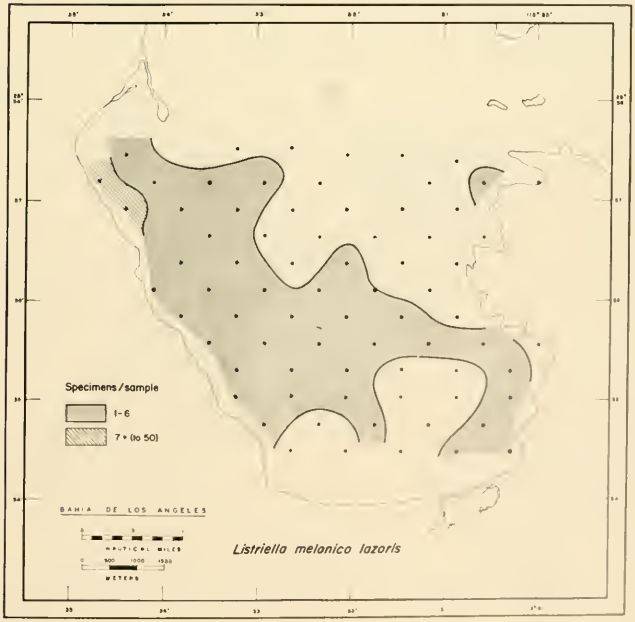

Figure 4. Distribution of *Listriella melanica lazaris* Barnard.

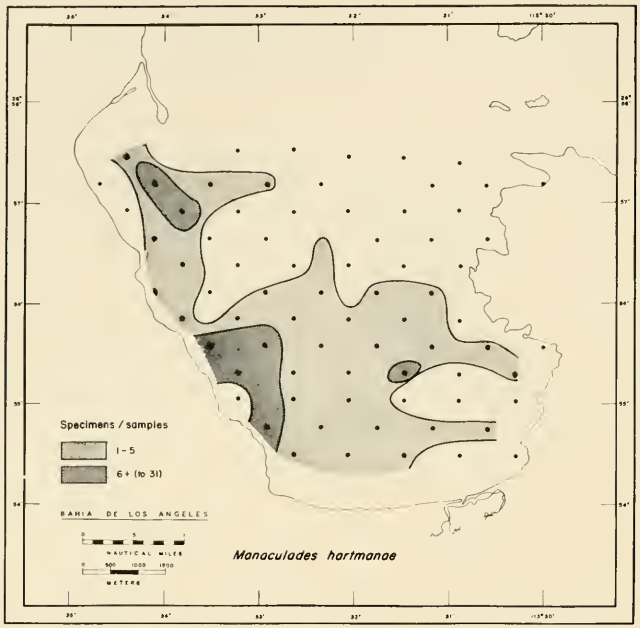

Figure 5. Distribution of *Monoculodes hartmanae* Barnard.

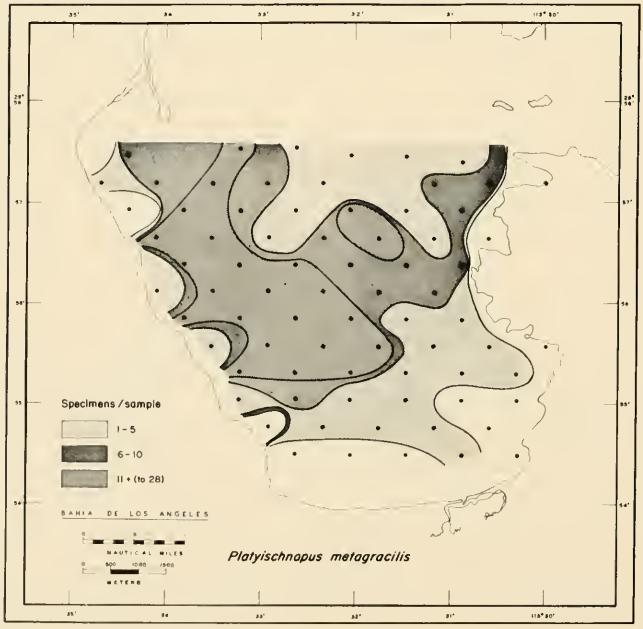

Figure 6. Distribution of *Platyischnopus metagracilis* Barnard.

(7) *Ampelisca hancocki,* collected by the "Velero III" near BLA in depths slightly exceeding those of this survey; (8) *Ampelisca indentata,* from California to Gulf of California; (9) *Ampelisca pugetica,* Washington to Angel de la Guarda Island, on shore at the latter; (10) *Byblis veleronis,* California to Gulf of California (Espiritu Santo Island, 38 m); (11) *Cerapus tubularis,* a eurylatitudinal cosmopolite; (12,13) *Cheiriphotis magacheles* and *Chevalia aviculae,* both tropical cosmopolites, occurring in southern California; (14) *Mandibuphoxus uncirostratus,* apparently a tropical Indo-Pacific species found as far north as southern California; (15) *Photis elephantis,* known from southern California and with records at hand from the Galapagos Islands. Other omissions from the BLA fauna include *Anamixis linsleyi, Batea lobata, Eurystheus spinosus, Leucothoides pacifica, Metaceradocus occidentalis, Metaphoxus frequens, M. fultoni, Parajassa angularis,* and *Pontogeneia minuta,* all but *Metaphoxus* spp. probably occur on hard bottoms, which have not been completely explored.

Affinities of the Fauna

Nine species and subspecies of BLA Gammaridea are cognates of forms with warm-temperate affinities; 20 species occur only in warm- and cold-temperate regions; 19 species occur in or have affinities with tropical waters; 2 species have unknown affinities; and the remaining 18 have eurylatitudinal distributions (Table 1). *Batea transversa coyoa* may also have direct warm-temperate affinities, although the genus *Batea* is mainly tropical in distribution. *Acuminodeutopus periculosus* is assumed to be a warm-temperate species, because to date the genus has been found only in warm-temperate regions. Of the unidentified species only *Pleustes* sp. has definite warm-temperate affinities. This is the southernmost record of the genus.

More than 70 per cent of the Gammaridea in BLA have non-tropical affinities, but if the eurylatitudinal species with unknown affinities are subtracted the percentage drops to 61 (30 of 49 species). Soule (1960) found that 57 per cent of the Bryozoa occurring in the northern third of the Gulf of California have non-tropical affinities. On the other hand, Garth (1960) found that only 8 per cent of the Brachyura have northern affinities, but his data included the entire Gulf.

Of the dominant Gammaridea with known affinities of soft-bottoms in BLA, 72 per cent (18/25) have affinities with warm regions; three species are tropical, 15 warm-temperate, and 7 eurylatitudinal.

Systematic Procedure

Classification follows that of Barnard (1958a). Distributional information excludes new records in BLA. Locality data occur in Barnard and Grady (1968). Materials are summarized in Table 1. For a complete Station list of specimens order NAPS Document 00308 from ASIS National Auxiliary Publications Service, c/o CCM Information Sciences, Inc., 22 West 34th Street, New York, N. Y., 10001; remitting $1.00 for each microfiche copy and $3.00 for each hard-copy reproduction. Samples 130 and 210, represented by aliquots, have their data expanded by factors of 100 and 10 respectively. Diverse substrate habitats of 4 species are summarized in Table 4. Sideheads of "Records" include summary of locality data, mainly depth; of "Relationships" include, with few exceptions, morphological differences from the nearest relative only, and occasional comments on classificatory problems arising from this study. Diagnoses and descriptions are condensed but they are widely supplemented by the figures. Decisions on categorical rank of new species and subspecies have no relationship to a numerical standard of differential characters but are based on the differences of known species in each genus. Body sizes, quoted in mm refer to body length. Derivations of new names are found in the appendix.

ORDER AMPHIPODA
SUBORDER GAMMARIDEA
Family Ampeliscidae

Ampelisca compressa Holmes
Figure 7 c

Ampelisca compressa Holmes. Barnard, 1960a: 31-32; 1964a: 213.

Antenna 1 of female reaching only to end of article 4 of antenna 2, flagellum with 5 articles, in contrast to populations of the open sea off southern California having antenna 1 reaching almost to the end of article 5 of the second antennal peduncle. Article 2 of peduncle of antenna 1 only 1.5 times as long as article 1, whereas in open sea specimens the article is twice as long as article 1. The entire first antenna is stunted in comparison to specimens from southern California. The head is more fully excavate below, appearing more narrow in the specimens from Bahía de Los Angeles.

Catalogued specimen. — USNM No. 111508, female, 6.7 mm, BLA 88.

Records.—Soft-bottoms, 15-46 m; in April, 152 individuals /m^2; in October with 9.0 individuals /m^2.

Distribution. — Western Atlantic Ocean; Caribbean Sea; eastern Pacific Ocean from Panamá to Puget Sound, Washington, 1-266 m.

Ampelisca cristata Holmes
Figure 7 a, b

Ampelisca cristata Holmes. Barnard, 1954a: 26-28, pls. 17, 18: 1964a: 213.

Female adults have article 2 of antenna about 1.9 times as long as article 1, in contrast to populations of the open sea off southern California having article 2 about 1.2 times as long as article 1. Juveniles have the open sea form of antenna 1 and subadults range from 1.4 to 1.7 in the relative length of article 2. The population in Bahía de Los Angeles is entirely of the microdentate form, having a minute tooth on pleonal epimeron 3. Uropod 3 has the outer ramus broader and more rounded apically than in specimens from southern California.

Records. — Soft-bottoms, 15-46 m; in April 527 individuals /m^2; in October with 43 individuals /m^2.

Distribution. — Caribbean Sea; eastern Pacfic Ocean from Ecuador to Tomales Bay, California, 6-152 m.

Ampelisca lobata Holmes

Ampelisca lobata Holmes. Barnard, 1954a: 11-14, pls. 5, 6; 1964a: 214.

Records. — Rocky intertidal on outer islands and at Vermilion Sea Field Station.

Distribution. — Caribbean Sea; eastern Pacific Ocean from Ecuador to Monterey Bay, California, 0-183 m.

Ampelisca mexicana Barnard

Ampelisca mexicana Barnard, 1954a: 45-46, pls. 31, 32; 1954b; 7; 1964a: 214.

Records. — Deep water zone of the bay, 25-46 m, primarily on silt-bottom but also on silty sand and fine sand.

Distribution. — Caribbean Sea at Bahía Caledonia, Panamá; eastern Pacific Ocean from Peru to Punta Canoas, Baja California, 9-73 m.

Ampelisca milleri Barnard

Ampelisca milleri Barnard, 1954a: 9-11, pls. 3, 4; 1964a; 215.

Material. — BLA SIO-X, one juvenile, 2.5 mm, fitting the description except for small differences; adults should be collected for better comparison.

Record. — Piedras Ahogadas, 24 m, shell fragment bottom.

Distribution. — Eastern Pacific Ocean from Ecuador and the Galápagos Islands to San Francisco Bay, California, 15-187 m; in shallow water at San Francisco.

Ampelisca schellenbergi Shoemaker

Ampelisca schellenbergi Shoemaker, 1933a: 3-5, fig. 2; 1942: 9. Barnard, 1954a: 14-16, pls. 7, 8; 1954b: 2.

Record. — Rocky intertidal of Vermilion Sea Field Station.

Distribution. — Caribbean Sea and Gulf of Mexico; eastern Pacific Ocean from Perú to Laguna Beach, California, 0-46 m.

Family Amphilochidae

Amphilochus neapolitanus Della Valle

Amphilochus neapolitanus Della Valle. Chevreux and Fage, 1925: 112-113, figs. 106-108. Barnard, 1962c: 126, fig. 3; 1964a:217; 1964b:105.

Record. — Sandspit north of village in tailings of fish sample.

Distribution. — Cosmopolitan in tropical and subtropical seas, 0-80 m.

Gitanopsis pusilloides Shoemaker

Gitanopsis pusilloides Shoemaker, 1942:9-11, fig. 3.

The unusual maxillipedal palp having 2 clavate spines on article 3 at the base of the finger is shown in the drawings.

Records. — Intertidal to 9 m on coarse substrate.

Distribution. — Bahía Magdalena, Baja California, possibly north to La Jolla, California; intertidal to about 20 m.

Figure 7. *Ampelisca cristata* Holmes, female, 7.0 mm, BLA 41: a, head; b, uropod 3. *Ampelisca compressa* Holmes, female, 6.7 mm, BLA 88: c, head. *Batea transversa coyoa*, new subspecies, female, 6.9 mm, BLA SIO-62-236: d, e, f, pereopods 3, 4, 5; g, gnathopod 2. *Gitanopsis pusilloides* Shoemaker, female, ovigerous, 1.8 mm, BLA 213: h, i, j, maxilliped and views of palp terminus, the latter with medial setae removed to show fused cusp-spines. *Hippomedon propinquus* Sars, female, 4.5 mm, BLA 103: k, l, gnathopod 2; m, gnathopod 1; n, antenna 1. *Ampithoe ramondi* Audouin, male, 6.3 mm, BLA SIO-62-210: o, p, gnathopods 1, 2.

Family Ampithoidae

Ampithoe plumulosa Shoemaker

Ampithoe plumulosa Shoemaker, 1938: 16-19, fig. 1; 1942: 39. Barnard, 1959a: 37; 1964b: 111; 1965: 20, figs. 11, 12.

Only juveniles and subadult females have been collected in BLA.

Record. — Intertidal at Vermilion Sea Field Station.

Distribution. — British Columbia to Ecuador, intertidal and shallow subtidal waters.

Ampithoe pollex Kunkel

Figure 8

Ampithoe pollex Kunkel, 1910: 92-94, fig. 36. Barnard, 1954c: 29-31, pls. 27, 28; 1959a: 37; 1964b, 111; 1965: 22-25, figs. 13, 14. Mills, 1964: 15-16.

Grubia indentata Stout, 1913: 656-657.

Three adult forms of this species occur in BLA. They may represent individuals hatched in different seasons.

Typical form, material: BLA 305 (3), SIO-62-216 (8): male gnathopod 2 is fully developed and has the dactyl and thumb meeting; specimens fit the descriptions given by Barnard (1965); maximum length about 5.5 mm.

Small form with aberrant gnathopod 2, material: SIO-62-215 (8); gnathopod 2 of the male has a shortened, thicker, more curved dactyl than in the typical form; the dactyl fails to meet the thumb; coxa 1 has a more excavate anterior margin than in the typical form; maximum length about 5.5 mm.

Large form with retarded gnathopod 2, material: BLA 305 (144), 306 (193); male gnathopod 2 is typical of juveniles although the body length exceeds 7.0 mm; the palmar tooth is poorly developed; specimens preserved in alcohol are more strongly pigmented than the other forms.

Material of juveniles and females not associated with males and thus unrecognizable as to form: BLA 214 (1), 306A (228), SIO-62-212 (3), 62-228 (3).

Records. — Intertidal on rocky shores.

Distribution. — Bermuda; eastern Pacific Ocean from Bahía de San Quintín, Baja California to Coos Bay, Oregon, intertidal and shallow sublittoral waters.

Ampithoe ramondi Audouin

Figure 7 o, p

Ampithoe ramondi Audouin. Shoemaker, 1942: 40. Barnard 1955a: 28-29 (with references); 1964a: 217; 1965: 25-27, figs. 15, 16.

Amphithoe vaillanti Lucas. Chevreux and Fage, 1925: 33-334, figs. 341, 242. Gurjanova, 1951: 880-881, fig. 614.

Ampithoe divisura Shoemaker, 1933b: 255-256, fig. 8.

Amphithoe intermedia Walker, 1904; 290-291, pl. 7, fig. 46. Chevreux, 1908: 515-516, fig. 29.

The references to this species have been condensed from a total of 55 or more published since 1900.

Male gnathopod 1 has a strongly excavate palm like that of male gnathopod 2. This is atypical of *A. ramondi* as found on the outer coast of Baja California and may indicate subspeciation.

Records. — Intertidal on rocky shores.

Distribution. — Tropicopolitan, phycophilous, intertidal; northern record in eastern Pacific Ocean at Bahía de San Ramón, Baja California.

Ampithoe tea Barnard

Ampithoe tea Barnard, 1965: 30-34, figs. 19-21.

The second antennal flagellum in both sexes is stouter than in the type-series. It resembles antenna 2 of *Ampithoe* sp. of Barnard (1965). Article 2 of pereopods 1-2 is short, as in the latter species. However, article 4 of antenna 2 is like that of the type series and is not shortened as in *Ampithoe* sp. Probably the latter is a rare individual of *Ampihoe tea* matching the phenotype in Bahía de Los Angeles but far removed geographically from its optimal home.

Records. — Intertidal on rocky shores; shell sand, 25 m.

Distribution. — Southern and Baja California from Santa Barbara and Catalina Island to Punta Eugenia and Guadalupe Island, intertidal to 67 m.

Family Aoridae

Acuminodeutopus periculosus, new species

Diagnosis. — Male gnathopod 1 having process of article 5 produced into 2 distal teeth, article 6 extending well beyond process of article 5; coxa 1 rather shallow, evenly extended forward; gnathopod 2 with article 2 distally expanded anteriorly, article 3 with long anterior process, longer than known for *A. heteruropus* Barnard (1959a); inner ramus of uropod 3 with 2 distal spines. Pereopods 1-2 similar to those of *A. heteruropus,* including 3 stout setae of article 5, otherwise with minor setal variations; pereopods 3-5 similar but with minor variations in setal placement; uropod 2 differing from that of *A. heteruropus* by possession of 2 marginal spines on outer ramus; eyes slightly larger and less elongated than those of *A. heteruropus.*

Holotype. — USNM No. 111461, male, 2.3 mm.

Type-locality. — BLA 39, April 24, 1962, 7 m.

Relationship.— Male gnathopod 1 of *Acuminodeutopus heteruropus* has a single tooth on article 5, a

Figure 8. *Ampithoe pollex* Kunkel, male, 7.0 mm, BLA 305, large retarded form: a, head and antennae; b, c, d, e, f, pereopods 1, 2, 3, 4, 5; g, h, gnathopods 1, 2; i, telson; j, k, uropod 3; l, lower lip; m, n, uropods 1, 2. Male, 5.4 mm, BLA SIO-62-215, small aberrant form: o, p, gnathopods 2, 1.

Figure 9. **Acuminodeutopus periculosus,** new species, male, 3.0 mm, BLA 116: a, b, gnathopod 1; c, d, e, gnathopod 2; f, uropod 3. Female, 3.0 mm: g, h, gnathopods 1, 2.

short article 6, and gnathopod 2 has an unexpanded article 2 and no process on article 3. All males of *A. periculosus* have the double cuspidation on article 5 of gnathopod 1 but the size and shape of the teeth vary considerably.

Records. — Scattered along the shallowest perimeter on both sides of Bahía de Los Angeles in depths of 4 to 38 m, mainly shallower than 15 m, persistent in both seasons, on bottoms of coarse sand and shell, rarely on fine sands.

Lembos macromanus (Shoemaker)

Bemlos macromanus Shoemaker, 1925: 36-41, figs. 10-13.

Lembos macromanus. Barnard, 1962a: 9, fig. 3; 1964b: 110, chart 12.

The largest male, 9.0 mm long, from BLA SIO-62-235, was figured in Barnard (1962a); its first gnathopod is similar to that shown by Shoemaker (1925) and the pereon has 2 sternal teeth. Another male of SIO-62-212 has the first gnathopod like that of *L. concavus* as identified by Barnard (1962a) but lacks anterior setae on article 6 and has 3 sternal teeth on the pereon.

Records. — Rocky intertidal to at least 9 m on coarse substrate.

Distribution. — Gulf of California north to Estero de Punta Banda (Ensenada), Baja California, shallow-water and intertidal.

Microdeutopus schmitti Shoemaker

Microdeutopus schmitti Shoemaker, 1942; 18-21, fig. 6. Barnard, 1959a: 32-33, pl. 9; 1961: 180; 1964a: 218.

The male of SIO-62-212 has a strong, sharp tooth on the anterodistal edge of article 2 on gnathopod 2; the tooth on the fifth article of gnathopod 1 is blunt, nearly spatulate, and lacks accessory teeth.

Records. — Rocky intertidal to 44 m, primarily on coarse substrate.

Distribution .— Monterey Bay, California, to Cabo San Lucas, Baja California, 0-43 m.

Neomegamphopus roosevelti Shoemaker

Neomegamphopus roosevelti Shoemaker, 1942; 36-38, fig. 13. Barnard; 1962a: 10.

Records. — Rocky intertidal to 24 m on shell sand.

Distribution. — Border of Mexico-California (32°N) to Cabo San Lucas, Baja California, 11-42 m.

Rudilemboides stenopropodus Barnard

Rudilemboides stenopropodus Barnard, 1959a: 31-32, pl. 8; 1964b; 110, chart 14.

Records. — In April from rocky intertidal to 38 m, with most of the records below 9 m; in October from 4 to 19 m, with most of the records from 9 m or less.
Distribution. — Pt. Conception, California to Bahía de San Quintín, Baja California, 1-68 m.

Family Argissidae

Argissa hamatipes (Norman)

Argissa hamatipes (Norman). Walker, 1904: 246. Stebbing, 1906: 277. Shoemaker, 1930: 37-40, figs. 15, 16. Stephensen, 1931: 261; 1935: 140; 1940: 41; 1944: 52. Gurjanova, 1951: 327-328, fig. 193. Barnard, 1962c: 151.
Argissa typica Boeck. Sars, 1895: 141-142, pl. 48.
Record. — Reef between Isla Ventana and Isla Cabeza de Caballo, shore.
Distribution. — North Atlantic in Gulf of St. Lawrence, Kattegat and northern Britain to Kola Bay; Greenland; Chukchi, Bering, Okhotsk and Japan seas; California; 4-1096 m.

Genus *Batea* Muller

Occasionally fully adult but more often juvenile specimens of both *Batea transversa* and *Batea rectangulata* have the evanescent teeth on the third pleonal epimera typical of *Batea lobata*. These are considered as mutants. *Batea lobata* is distinguished from *B. catharinensis* largely by this difference, the evanescence of teeth on the third pleonal epimera, although the gnathopods are slightly different. *Batea lobata* might be considered a Pacific race of the Atlantic *B. catharinensis*, but a second Pacific cognate of *B. catharinensis*, sympatric with *B. lobata*, is described below.

Key to Species of *Batea* (Note that coxa 1 is absent in this genus)

1a. Coxa 2 quadrate ..... *rectangulata*
b. Coxa 2 subtriangular 2
2a. Palm of gnathopod 2 oblique 3
b. Palm of gnathopod 2 nearly transverse ..... *transversa*
3a. Teeth of third pleonal epimeron well developed 4
b. Teeth of third pleonal epimeron obsolescent ..... *lobata*
4a. Articles 5 and 6 of gnathopod 2 equal in length; lobe on article 2 of pereopod 3 poorly developed; distal half only of inner margin of mandibular palp article 2 setose; rostrum evenly tapering ..... *susurrator*, n.sp.
b. Article 5 of gnathopod 2 slightly shorter than article 6; lobe on article 2 of pereopod 3 well developed; all of inner margin of mandibular palp article 2 setose; rostrum tapering unevenly ..... *catharinensis*

Batea rectangulata Shoemaker

Batea rectangulata Shoemaker, 1925: 31, figs. 7-9; 1926: 9-13, figs. 5-7.

Although other species of *Batea* in Bahía de Los Angeles differ from their cognates or their warm-temperate relatives, this species, originally described from Bahía de San Francisquito, Gulf of California, does not. Gnathopods, pereopods, head, and pleonal epimera correspond to those figured or described by Shoemaker.
Records. — In April from 7 to 40 m, primarily below 15 m, on coarse sand and shell, scarce on fine sand; in October occurring sparsely between 2 and 9 m.
Distribution. — Bahía de San Francisquito, Gulf of California.

Batea susurrator, new species

Figure 10

Diagnosis. — Rostrum tapering acutely and almost evenly; postantennal corner of lateral cephalic lobe sharp, quadrate; mediodistal edge only of mandibular palp article 2 setose; lower lip lacking medial lobes; articles 5 and 6 of gnathopod 1 subequal in length, both relatively thinner than in *B. catharinensis* (see Shoemaker, 1926), palm oblique, slightly shorter than posterior edge of article 6, thus palm shorter than in *B. catharinensis;* coxa 1 subtriangular; posterodistal corner of article 2 on pereopod 3 nearly quadrate, not lobate; posteroventral rounded margin of article 2 on pereopod 5 with deep slit, article 2 slightly broader than in *B. catharinensis;* telson cleft slightly less than halfway, edges proximally appressed closely, distally gaping; posterior edge of third pleonal epimeron strongly serrate in adult, weakly in juveniles. Pleonal epimera, uropods and mouthparts, except for mandibular palp and lower lip resemble those of *B. catharinensis;* maxilla 1 with more setae on inner plate than in *B. catharinensis* despite size differences: when outer plate of maxilliped bears 2 spine-setae distally, inner plate of maxilla 1 bears 8 setae; in *B. catharinensis* when outer plate of maxilliped bears 4 spine-setae, inner plate of maxilla 1 bears only 5 setae. Antenna 1 of *B. susurrator* bearing a distal cusp on medial surface of article 1, not known for *B. catharinensis*.
Holotype. — USNM No. 111485, male, 4.2 mm.
Type-locality. — BLA 132, April 22, 1962, 25 m.
Relationship. — This species differs from its cognate of the Caribbean-western Atlantic, *B. catharinensis*, by the lack of proximal setation on the medial edge of mandibular palp article 2; the shape of gnathopod 2, its palm and posterior lobe of article 5; the lack of a prominent lobe on article 2 of pereopod 3; the evenly tapering rostrum. *Batea susurrator* resembles *B. transversa* Shoemaker (1926) but differs from that species in the absence of a lobe on article 2 of pereopod 3, the much larger second gnathopod with its more prominent and oblique palm, and the posterior lobe of article 5. *Batea susurrator* might be con-

Figure 10. **Batea susurrator,** new species, male, 4.3 mm, BLA 132: a, head; b, c, d, e, f, pereopods 1, 2, 3, 4, 5; g, h, i, uropods 1, 2, 3: j, telson; k, medial surface of article 1 of antenna 1; l, mandibular palp; m, n, gnathopods 1, 2; o, pleonal epimera 2-3, left to right. Juvenile, 2.4 mm: p, pleonal epimeron 3, left side.

fused with adults of *B. lobata* Shoemaker (1926) but again, the lack of a third pereopodal lobe, the larger gnathopod 2, and the sharper lateral cephalic lobes distinguish it, although the well-developed serrations of the adult third pleonal epimeron are significant. Juveniles of *B. susurrator* have poorly developed serrations but their other characters do not match those of *B. lobata*.

Records. — Ranging from 9 to 37 m in depth, most abundant in 25 m on coarse gray sand.

Batea transversa coyoa, new subspecies

Figure 7 d, e, f, g

Diagnosis. — Differing from *B. t. transversa* Shoemaker (1926), by absence of posteroventral lobe on article 2 of pereopod 3, by the more slender second articles of pereopods 4 and 5, the very slightly shorter fifth article of gnathopod 2 and by the more oblique palm.

Holotype. — USNM No. 111458, female, 6.9 mm, ovigerous.

Type-locality. — BLA SIO-62-236, south arm of Bahía de Los Angeles, April 26, 1962, ca. 30 m, shrimp trawl on N-S line between stations 156 and 45, coll. by Dr. Carl L. Hubbs' party.

Relationship. — *Batea susurrator* differs from *B. t. coyoa* in the expanded article 6 of gnathopod 2 and the presence of a slit on article 2 of pereopod 5. *Batea t. coyoa* resembles a specimen of *B. t. transversa* from Catalina Harbor California (Shoemaker, 1926, figs. 9 and 11) more than it does another specimen from Pt. Loma, California (Shoemaker, 1926, figs. 8 and 10). Correspondence is noted in the shapes of coxae 5-6 and articles 5-6 of gnathopod 2. Gnathopod 1 of *B. t. coyoa* resembles that in figure 9c of Shoemaker, especially notable being the contrast to *B. susurrator* and *catharinensis* in number, size, shape and arrangement of setae.

Records. — On coarse substrate from 9 to 30 m.

Distribution of *B. t. transversa*. — Southern California, 2-27 m.

Carinobatea Shoemaker, 1926

Carinobatea differs from *Batea* in the presence of dorsal cusps on posterior segments and the elongate article 1 of the palp on maxilla 1. Heretofore the absence of inner lobes on the lower lip of *Carinobatea* appeared significant as a generic character but the type-species of *Batea*, *B. catharinensis* (Atlantic) also lacks inner lobes. The Pacific members of *Batea* have inner lobes and this should be evaluated as a generic character.

If dorsal cusps alone were the characters distinguishing *Carinobatea* from *Batea,* there would be good cause to synonymize the genera because this kind of difference has rarely proved significant in other Gammaridea. Characters other than the first maxillary palp are assorted in *Carinobatea* much as they are in *Batea* and this would suggest a polyphyletic origin of the several species of *Carinobatea* from those of *Batea*. But, the consistency in first maxillary palp indicates a monophyletic development of *Carinobatea*.

Heretofore the enlarged process on article 1 of antenna 1 in members of *Carinobatea* represented a good generic character, but a new species to be described below has the small process typical of *Batea*.

Carinobatea conductor, new species

Figure 11

Diagnosis. — Rostrum of medium length and stoutness in contrast to other species of *Carinobatea* (having either shorter or longer rostra); distoventral tooth of article 1 of antenna 1 smaller than in other species; gnathopod 1 bearing only 2 distal setae (in contrast to 6 or more in other species); gnathopod 2 with short article 3 (in contrast to its elongation in *C. cuspidata* Shoemaker, 1926), article 5 longer than 6, its posterior lobe shallow and not pointing distally, palm oblique, equal to posterior margin of article 6; article 2 of pereopod 3 linear, lacking posterodistal lobe; posterodistal lobe of article 2 of pereopod 5 broadly expanded and deeply rounded (in contrast to *C. carinata* Shoemaker, 1926, having a shallow, quadrate lobe); lateral margin of peduncle of uropod 1 with about 10 spines (compared with 24 in *C. cuspidata* and about 11 in *C. carinata*); uropod 3 with flat, broad, heavily setose rami (in contrast to *C. carinata* but not *C. cuspidata*); pleonites 1 and 2 each with small dorsal tooth, pereonite 7 lacking tooth (in contrast to other species).

Holotype.—USNM No. 111495, ? male, 4.0 mm.

Type-locality. — BLA SIO-62-216, reef between Isla Ventana and Isla Cabeza de Caballo, shore, debris of fish sample, April 21, 1962, coll. Dr. Carl L. Hubbs and party.

Relationship. — Similarities and contrasts to other species are stated in the diagnosis. The diversity of characters among species of *Carinobatea* is much stronger than in *Batea* with differences in dorsal body cusps, length of article 3 of gnathopod 2, striking differences in uropod 3 (see *C. cuspidata*), peduncular spines of uropod 1, article 2 of pereopod 5, and the cusp on article 1 of antenna 1. In their linear second articles of pereopod 3 all species of *Carinobatea* resemble *Batea susurrator, B. transversa coyoa* and *B. catharinensis*.

Mouthparts of *C. conductor* correspond to those figured by Shoemaker for *C. cuspidata*, especially in the 4.0 mm male. The larger, 5.0 female has only a single accessory seta on article 3 of the mandibular palp; both sexes have a small distal cusp concealed in the terminal setae of that article; the inner plate of maxilla 1 has 5-6 setae; in the female the first palp article of maxilla 1 is not as elongate as in both sexes of *C. cuspidata* but the distal end of the palp is more strongly armed.

Figure 11. **Carinobatea conductor,** new species, male, 4.0 mm, BLA SIO-62-216: a, head; b, c, gnathopod 2; d, e, medial surfaces of antennae 2, 1; f, g, h, uropods 1, 2, 3; i, telson; j, k, l, m, pereopods 1, 3, 4, 5; n, coxa 4; o, gnathopod 1. Female, 5.0 mm: p, pleonal epimera 1-3, left to right; q, lateral surface of article 1 of antenna 1.

Family Corophiidae

Corophium baconi Shoemaker

Corophium baconi Shoemaker, 1934: 356-359, fig. 1; 1949, 82. Barnard, 1959a: 38; 1961: 182; 1964b: 111-112, chart 16; 1964a: 219.

Records. — Rocky intertidal to 9 m.

Distribution. — Generally a species of lagoons and estuaries but occurring in the open sea from Perú to the Bering Sea; off southern California in depths of 9-55 m and in 1-2 m in enclosed bays and harbors.

Corophium uenoi Stephensen

Corophium uenoi Stephensen 1932: 494-498, figs. 3, 4. Barnard, 1952: 28-32, pls. 8, 9; 1959a: 39. Nagata, 1960: 178. Barnard, 1961: 183; 1964b: 112, chart 16.

The accessory tooth above the large ventral tooth on article 4 of male antenna 2 is slightly larger and blunter than in specimens from southern California.

Records. — Rocky intertidal of Vermilion Sea Field Station.

Distribution. — Japan; eastern Pacific Ocean from Monterey Bay, California at 24 m, to Bahía de San Quintín, Baja California, rarely occurring in the open sea, more often in lagoons and estuaries, such as Morro Bay, Newport Bay, and Bahía de San Quintín, intertidal to 2 m.

Ericthonius brasiliensis (Dana)

Ericthonius brasiliensis (Dana). Barnard, 1955a: 37-38; 1959a: 39; 1961: 183; 1964a: 219.

Records. — From 0 to 42 m, primarily on intertidal or very shallow sand bottoms.

Distribution. — Cosmopolitan in tropical, warm-temperate and some boreal seas, 0-130 m.

Rildardanus, new genus

Diagnosis. — Antenna 2 strongly ornamented; mandibular palp 3-articulate; inner plates of maxillipeds broad, flat; gnathopod 1 in male much larger than 2, both pairs subchelate; accessory flagellum uniarticulate, vestigial; inner rami of both uropods 1 and 2 scale-like, vestigial; uropod 3 composed only of a setose peduncle; telson a large subcircular, simple flap.

Type-species. — **Rildardanus tros,** new species.

Relationship. — The shortened, scale-like inner rami of uropods 1-2 relate this genus to *Pseudericthonius* Schellenberg (1926), but that genus has a well-developed third uropod with a long ramus. *Concholestes* Giles (1888) is the only other genus in the Corophiidae lacking rami on uropod 3 but the rami of uropod 1 of that genus are not reduced, gnathopod 2 is larger than 1 and the second antenna is not ornamented. The unelongate first urosomal segment prevents assignment of this genus to the Podoceridae. Gnathopods of *Rildardanus* resemble those of *Unciola* most closely and probably *Rildardanus* is allied to that genus, especially in view of the similarity of pleonal epimera (Sars, 1895, pl. 222), coxae, pereopods and mouthparts. This genus differs from *Unciola* in the loss of the ramus of uropod 3, further enlargement and special ornamentation of male antenna 2 and almost complete loss of the accessory flagellum. The second antennae are ornamented as much as or more than they are in *Corophium* but the mouthparts and gnathopods strongly differ in *Rildardanus* (compare *Corophium* in Sars, 1895, pls. 219-221).

Rildardanus tros, new species

Figures 12, 13

Diagnosis. — With characters of the genus.

Description of male. — Rostrum small, acute; lateral cephalic lobes rounded, article 3 of antenna 2 overriding them and fitting behind a ventral accessory lobe; eyes small, composed of few ommatidia; article 1 of antenna 1 bearing 4 ventral spines and medial ridge with 5 spines; article 2 as long as 1; article 3 shorter than 1, accessory flagellum minute, uniarticulate; antenna 2 fitting snugly to oblique lower edge of head, article 1 large, triangular, article 2 evanescent laterally, evidenced by its blunt gland-cone, article 3 broadened, with 1 dorsal spine on a poorly developed process distally produced laterally, medial face with semicircle of stout spines; article 4 more slender, mediodistal end strongly produced acutely and bearing apical spine, lower edge when properly turned showing 5 ventral cusps each with stout spines; article 5 very slender, about as long as 4; lateral surfaces of pereonites with bulges just dorsal to coxae; anterior coxae small and acute anteriorly, fifth coxa largest, last 3 coxae with small, hemispherical posterior lobes; gnathopods small, first larger than second, article 5 short, with blunt posterior lobe, article 6 long, stout, posteroproximal end of article 6 produced into blunt tooth defining false palm, finger slightly overlapping defining process, inner edge armed with sharp cusps; gnathopod 2 slender, articles 5 and 6 equal in length, article 5 poorly setose anteriorly and lacking posterior lobe, palm of article 6 transverse, somewhat cheliform, defined by stout spine, dactyl overlapping palm; pereopods simple, each sixth article with small distal spine at base of dactyl, pereopods 4 and 5 equal in length, pereopod 3 very short, second articles of last 3 pereopods bearing plumose setae on both anterior and posterior edges; pleopods well-developed, decreasing in size slightly from pleopod 1 to pleopod 3, each pleopod armed with 1 or 2 rasp-like coupling hooks; pleonites distinct, lateral surfaces of 4 and 5 with ridge, first 2 pleonal epimera with sinuoconvex posterior edges and sharp cusps at posteroventral corners, third pleonal epimeron with cusp produced from anterior portion of ventral edge; uropod 1 slightly exceeding uropod 2, uropod 2 very short, inner rami about one fourth as long as outer, scale-like, each armed with distal spine, uropod 3 a simple, asymetrically expanded, terminally setose peduncle attached to remnant of pleonite 6 below telson; telson a large, subcircular, simple flap; mouthparts

Figure 12. **Rildardanus tros,** new genus, new species, male, 4.5 mm, BLA 212: a, lateral view; b, pleopod 3, minus setae; c, lateral view of head showing coupling process of antenna 2; d, coupling spine of pleopod; e, pleopod 1, plumosities of setae shortened and reduced in number for clarity; f, medial view of antenna 2, minus setae; g, pleonal epimera 1-3, left to right; h, dorsal view of head.

Figure 13. **Rildardanus tros,** new genus, new species, male, 4.5 mm, BLA 212: a, lower lip; b, c, antennae 1, 2, medial views; d, accessory flagellum; e, gnathopod 1; f, g, gnathopod 2; h, i, uropod 1, lateral and medial views showing small inner ramus; j, k, uropods 2, 3; l, dorsum of telson and third uropods; m, n, maxillae 1, 2; o, maxilliped; p, mandible; q, upper lip.

figured, generally typical of unciola-ericthonius corophiids, outer plate of maxilla 1 with 9 spines. Female unknown.

Holotype. — USNM No. 111518, male, 4.5 mm.

Type-locality. — BLA 212, main west shore of Bahía de Los Angeles, west of Isla Ventana, dredge of sand bottom, *Ulva* and gracilarioids, 9-16 m, April 28, 1962.

Family Dexaminidae

Polycheria osborni Calman

Figure 25 g

Polycheria osborni Calman, 1898: 268-269, pl. 32, fig. 2. Skogsberg and Vansell, 1928: 268-282, figs. 1-26. *Polycheria antarctica* (Stebbing). Alderman, 1936: 63. Barnard, 1954c: 21 (not Stebbing, 1888).

Except for a greater setosity of mouthparts, uropods and thoracic appendages, these specimens fit the morphology depicted by Skogsberg and Vansell (1928). The pleonal epimera are drawn here because they were not decribed by Skogsberg and Vansell. Coxae 1 and 2 are less strongly produced and the mandibular lobes are better developed in BLA specimens than in those from Monterey Bay, California, described by Skogsberg and Vansell.

So much variation has been demonstrated for *P. antarctica* in the southern hemisphere (especially by Schellenberg, 1931), that through a series of changes *P. osborni* has become a synonym of *P. antarctica* (*P. osborni* to *P. tenuipes* by Stebbing, 1906; *P. tenuipes* to *P. antarctica* by Stebbing, 1910). Skogsberg and Vansell indicated the inadvisability of such changes. A character that seems to distinguish *P. osborni* from other known species and formae is the dense setation of the ventrolateral margin of the peduncle of uropod 1; the pleonal epimera also may be characteristic but they require description on various forms.

Record. — Rocky intertidal, in tunicates, Vermilion Sea Field Station.

Distribution. — Puget Sound, Washington to southern California (32° N), intertidal, especially in amarouciid tunicates.

Family Eusiridae

Pontogeneia nasa, new species

Figures 14, 15

Diagnosis of male. — Rostrum decurved, scarcely tapering, extending twice as far as lateral cephalic lobes, the latter disymmetrically rounding, anteroventral margin of head straight, then slightly attenuated to acute corner; eyes large; mandibular palp massive, article 2 broad, strongly setose mediodistally, article 3 more than 80 percent as long as article 2, setose medially for most of its free length; inner plate of maxilla 1 with 3 terminal-subterminal setae, lateralmost very massive, medialmost subterminal; apices of inner maxillipedal lobes narrower than in *P. longleyi* Shoemaker (1933b); posterodorsal ends of pleonites 1-2 projecting above following segments as in *P. longleyi* and *P. quinsana* Barnard (1964b); third pleonal epimeron serrate behind, first and second epimera with small tooth and notch at posteroventral corners; second articles of all pereopods somewhat thinner and relatively longer than in *P. longleyi* and *P. quinsana;* rami of uropod 2 shorter than in *P. quinsana* and telson more deeply cleft, not as deeply as in *P. longleyi;* male gnathopods like those of *P. quinsana,* gnathopod 1 slightly larger than 2, article 5 of gnathopod 2 with narrow, sharp, somewhat distally pointing lobe, posterior margins of sixth articles of both pairs of gnathopods with 5-6 sets of stout spines, palm with larger spine on each side, palm poorly defined from posterior margin of article 6 if judging by length of dactyl; dactyls of all pereopods with striate medial ridge (also shown by Shoemaker for *P. longleyi);* antennae two thirds as long as body, armed with sense organs.

Female. — Serrations of third pleonal epimeron poorly developed; fifth articles of gnathopods similar to male, sixth articles small, narrow, palms oblique, spines at defining corners more numerous than in most female pontogeneias; mandibular palp with article 2 scarcely broadened.

Mouthparts (mandibular body, outer plate and palp of maxilla 1, maxilla 2, outer plate and palp of maxillipeds) like those of *P. longleyi* except as stated or figured; lower lip with outer lobes narrower than in *P. longleyi.*

Holotype. — USNM No. 111418, male, 5.0 mm.

Type-locality. — BLA SIO-62-235, north of BLA village sandspit. beach poisoning, shore, debris of fish sample, April 26, 1962 Dr. Carl L. Hubbs and party coll.

Relationship. — Resembles *Pontogeneia quinsana* Barnard (1964b) in the unusual serrations of the third pleonal epimera and the shape of the rostrum. The latter feature also occurs in *P. longleyi* Shoemaker (1933b), the male of which is unknown. The second articles of the pereopods are narrower in *P. nasa* than in the other two species and small details of serrations are different (compare figures of the various species); the serrate third pleonal epimera differentiate the new species from *P. longleyi* as does the long third mandibular palp article and the very broad second article differentiates *P. nasa* from both species. The telsonic cleft is intermediate in size, and the spination of the male gnathopods differs from that of *P. quinsana.* The distal articles of the pereopods of *P. quinsana* are not known but the striated ridges of the dactyls are apparently similar to those of *P. longleyi.*

The female has article 5 of gnathopod 2 projecting more strongly and turned more distally than in *P. longleyi* or *P. quinsana.*

Record. — Rocky intertidal to subintertidal on coarse substrate.

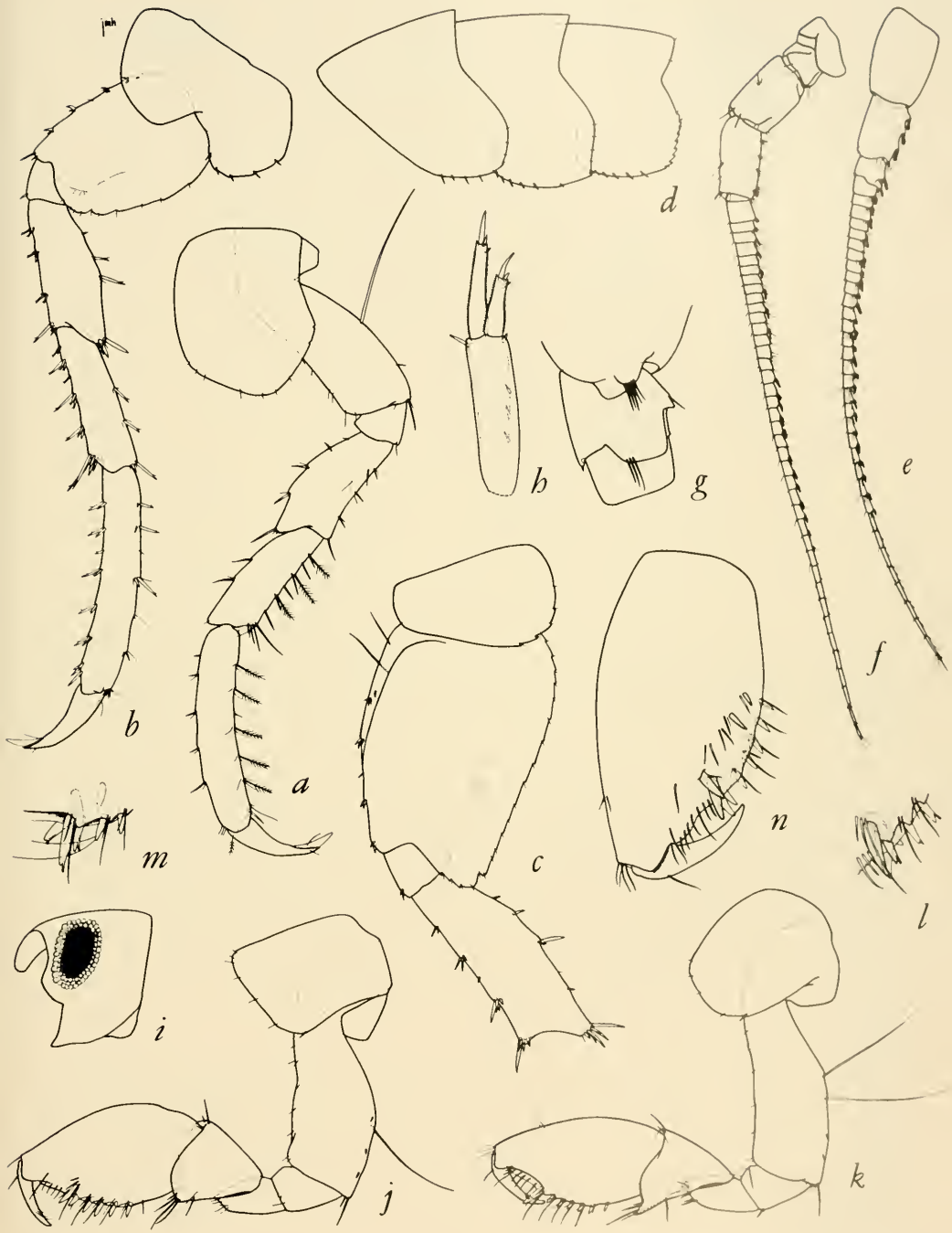

Figure 14. **Pontogeneia nasa,** new species, male, 5.0 mm, BLA SIO-62-235: a, b, c, pereopods 2, 3, 5; d, pleonal epimera 1-3, left side; e, f, antennae 1, 2; g, articles 2, 3, 4 of antenna 1, medial; h, ventral surface of uropod 2; i, head; j, k, gnathopods 1, 2; l, m, defining spines of palms of gnathopods 1, 2; n, medial surface of articles 6-7 of gnathopod 2.

Figure 15. **Pontogeneia nasa,** new species, male, 5.0 mm, BLA SIO-62-235: a, uropod 3; b, inner plate of maxilla 1; c, telson; d, mandibular palp; e, articles 3-4 of maxillipedal palp; f, inner plate of maxilliped. Female, 5.4 mm: g, mandibular palp; h, i, gnathopods 1, 2; j, dactyl of pereopod 1. Male, 5.1 mm: k, mandibular palp. Male, young 4.6 mm: l, m, medial surfaces of articles 6-7 of gnathopods 1, 2.

Rhachotropis luculenta, new species
Figure 16

Diagnosis of male. — Head flattened, with very long, decurrent rostrum, lateral cephalic lobes strongly projecting, falciform, apically obtuse; eyes very large, extending onto dorsal surface of head; mandibular palp article 2 about 80 percent as long as article 3; only pleonites 1 and 2 with posterodorsal tooth, segment 3 with 2 small posterior cusps on each side; pleonites 1-2 with posterolateral tooth on each side, that of segment 2 connected to a lateral carina; pleonal epimera rounded at posteroventral corners, third with serrate posterior edge; dactyls of pereopods 1-2 nearly as long as sixth articles; second articles of pereopods 3-4 very short, broad, posterior edges with 2-3 rather large serrations; second article of pereopod 5 intermediate in width, anterior and posterior edges parallel, posteroventral corner not lobate, bearing 2 large serrations; telson cleft about halfway.

Female. — Eyes small, about two thirds as broad as length of rostrum; antenna 1 of normal female configuration.

Holotype. — USNM No. 111546, male, 4.6 mm.

Type-locality. — BLA 124, 42 m, April 24, 1962.

Relationship. — This species is most similar to *Rhachotropis inflata* (Sars, 1895, pl. 152) but differs by (1) the absence of lateral carinae on pleonite 3 and the presence of 2 posterior cusps on the posterodorsal margin of each side; (2) the longer and more strongly deflexed rostrum; (3) the longer dactyls of the first 2 pairs of pereopods; (4) the very broad, short, second articles of pereopods 3 and 4 with their larger and less numerous teeth; (5) the small teeth on the unproduced posteroventral corner of the second article of pereopod 5; and (6) a greater disproportion between the lengths of the fourth and fifth peduncular articles of antenna 2. It resembles *R. oculata* (Hansen) (Gurjanova, 1951) in cephalic shape but differs by the absence of a dorsal tooth on pereonite 7 and pleonite 3, the absence of a tooth on the posteroventral corner of the second pleonal epimeron and the relatively parallel edges of the second article on pereopod 5.

No male accessory flagellum has been detected; a small, fused scale with setae is present on the mediodistal edge of article 3 of antenna 1; the female bears a uniarticulate accessory flagellum.

Records. — On silt bottom in 38-46 m; possibly represented by 1 specimen in "Velero" Sta. 5114, southern California (Allan Hancock Foundation).

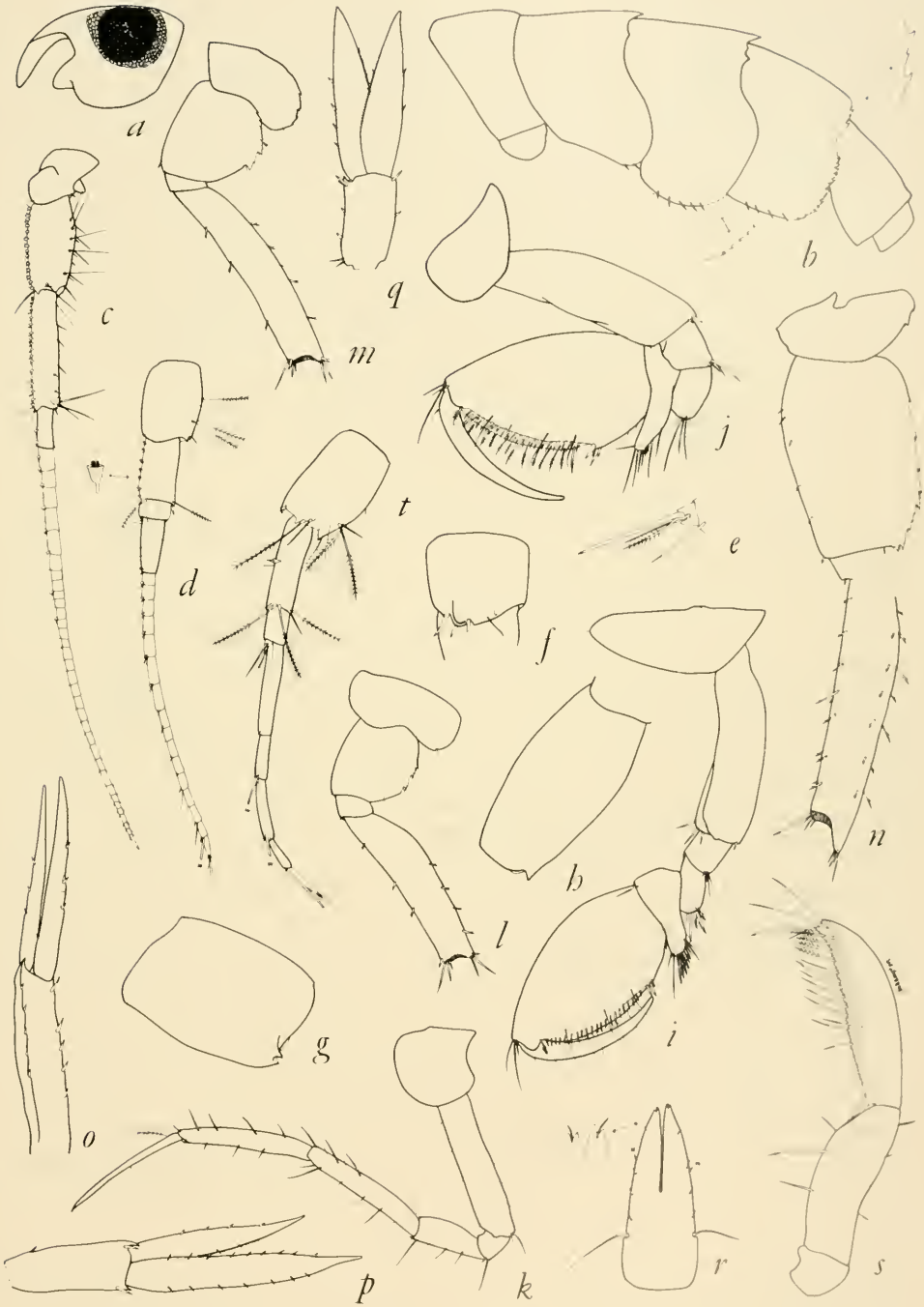

Figure 16. **Rhachotropis luculenta,** new species, male, 4.6 mm, BLA 124: a, head; b, pereonite 7 and pleonites 1-5, left side; c, d, antennae 2, 1; e, accessory flagellum; f, article 3 of antenna 1; g, article 1 of antenna 1; h, article 4 of antenna 2; i, j, gnathopods 1, 2; k, l, m, n, pereopods 1, 3, 4, 5; o, p, q, uropods 1, 2, 3; r, telson; s, mandibular palp. Female, BLA 95: t, antenna 1.

Figure 17. **Megaluropus longimerus falciformis**, new subspecies, female, 4.1 mm, BLA SIO-62-228: a, maxilliped; b, c, uropods 1, 2; d, mandibular palp; e, antenna 1; f, peduncular process of uropod 1. Male, 3.6 mm: g, head; h, i, coxae 1, 3; j, gnathopod 2. Female, 5.1 mm: k, telson; l, pleonites 1-5, left to right; m, head. Juvenile, 2.6 mm: n, uropod 3. *Megaluropus longimerus* Schellenberg, southern California, "Velero" station 5564, female, 6.5 mm: o, half of telson; p, pereopod 2. Female: 3.9 mm: q, both halves of telson.

Elasmopus rapax Costa

Elasmopus rapax Costa. Barnard, 1955a: 10-12, fig. 5 (with references); 1962b: 94-96, figs. 16, 17.
Elasmopus rapax mutatus Barnard, 1962b: 96-98 fig. 18.

One form of this species was reported by Barnard (1962b) from BLA but a second form occurs in SIO collections. It resembles a form from southern California (Barnard, in press) that has article 2 of pereopod 5 strongly crenellated posteriorly. A third form from Tiburón Island, near BLA, is also described by Barnard and an open-sea subspecies, *E. r. mutatus* occurs in southern California (Barnard, 1962b).

The second form from BLA is characterized as follows: pleonal epimeron 3 like that of *E. antennatus* and *E. holgurus* (see Barnard, 1962b), with smooth posterior margin and small tooth at posteroventral corner; accessory flagellum elongate, 2-articulate, article 2 minute; gnathopod 2 like that of *E. r. mutatus*, bearing one distal palmar process and one process in middle of palm as large as that of *E. r. rapax* of Barnard (1962b), but setae denser, invading palm halfway and hiding middle process, proximal palmar ridge and spine absent; telson short, truncate and heavily spined as in *E. holgurus* Barnard (1962b) and the crenellated form (Barnard, in press); uropod 3 short but inner ramus not shortened, outer ramus with 3 sets of marginal spines.

The wide variability in assortment of characters on accessory flagella, second gnathopods, fifth pereopods, third pleonal epimera, third uropods and telsons suggests that *E. holgurus* may be another phenotype of *E. rapax*.

Records. — Rocky intertidal of Vermilion Sea Field Station and barrier islands, to 24 m on barrier island reef.

Distribution. — Circumtropical, subtropical and in some temperate seas.

Maera inaequipes (Costa)

Maera inaequipes (Costa). Barnard, 1959a: 25-26, pl. 5.

The specimens correspond morphologically with those reported by Barnard (1959a) from Newport Bay, California. The question of the assignment of northeastern Pacific representatives to the European species remains open to further study.

Records. — Rocky intertidal of barrier islands.

Distribution. — Possibly circumtropical and warm-temperate in the intertidal.

Megaluropus longimerus falciformis, new subspecies

Figures 17, 18

Diagnosis. — Lateral cephalic lobe with sharp cusp anteriorly; posterior edges of pleonal epimera 1-3 strongly rounded, ending posteroventrally in small cusps, 2 and 3 sparsely serrate posteriorly; dorsal edges of pleonites 3, 4, 5 strongly serrate; coxae 1 and 2 longer than broad, coxae 2-3 reniform, curved posteriorwards, coxae 3-4 poorly setose, see drawings for sexual differences; article 4 of gnathopods in both sexes strongly produced distally and posteriorly, lobe of article 5 well-developed and directed somewhat distally in female, less strongly distinct from article 5 in male; long falciform spines on distal articles of all pereopods extraordinarily stout and distally blunt; second articles of pereopods 3-5 more slender than in southern California individuals; telson short, very broad, apices broad, nearly truncated, armed with long, stout blunt spines, telson extending only halfway along inner ramus of uropod 2.

Holotype. — USNM No. 111475 female, 4.1 mm.

Type-locality. — BLA SIO-62-228, W. shore of bay, south of village, debris of fish sample on cobble bottom, 2 m, April 24, 1962, coll. Dr. Carl L. Hubbs and party.

Relationship. — This subspecies differs from *M. l. longimerus* Schellenberg (as described from California by Barnard 1962b) in (1) the more strongly convex posterior edges of the pleonal epimera and their smaller posterodistal teeth; (2) the presence of a distinct cusp on the lateral cephalic lobes in both sexes; (3) the bluntness of the pereopodal spines; (4) the broader telson with longer, blunter distal spines; and (5) the poor setation of coxae 3 and 4.

Megaluropus longimerus was originally described from western Africa and its identification from the eastern Pacific Ocean is open to question on geographic grounds. If the taxon has subspeciated in a small geographic area then it may also be represented by different subspecies in California and Africa. The original description is sketchy and the material should be reevaluated in light of various characters differentiating the two Pacific subspecies. The telson and pereopod 2 of Californian material are reillustrated herein (fig. 17, o, p, q) for comparison of spines with specimens from BLA.

Distribution. — Lagos, Nigeria; eastern Pacific Ocean from Monterey Bay, California to Bahia de San Ramón, Baja California, 10-108 m.

Megaluropus visendus, new species

Figures 19, 20

Diagnosis. — Rostrum long, slender, acute, reaching nearly to end of article 1 of antenna 1, lateral cephalic lobes bulbously produced and broadly rounded; eyes large, filling lateral lobes; antennae slender in female, article 5 of second antennal peduncle much longer than article 4, accessory flagellum uniarticulate; male antenna 2 peduncular base inflated, densely setose; upper lip scarcely incised; inner plate of maxilla 1 with 1 stout distal seta and numerous, slender setules lining medial edge; article 4 of maxillipedal palp short, armed with 1 long stout spine and several setae; coxa 1 broad, anterior edge sinuous, with anterior concavity above anteroventral corner; coxa 2 much broader than 1, truncate and slightly concave on ventral edge; coxa 3 scarcely different from coxa 1 in size, anterodistal edge beveled; coxa 4 much larger

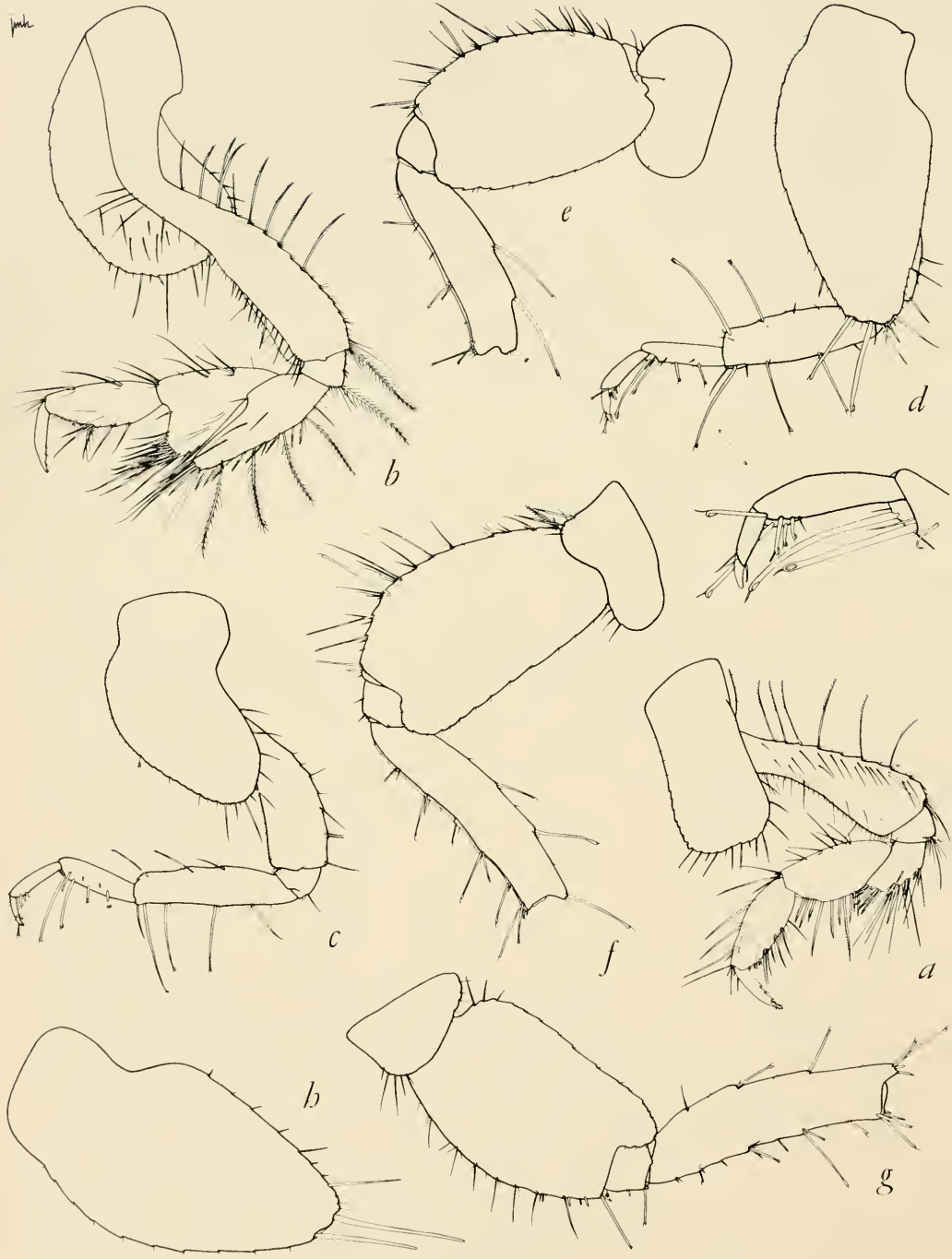

Figure 18. **Megaluropus longimerus falciformis**, new subspecies, female, 4.1 mm, BLA SIO-62-228: a, b, gnathopods 1, 2; c, d, e, f, g, pereopods 1, 2, 3, 4, 5. Male, 3.6 mm: h, coxa 4.

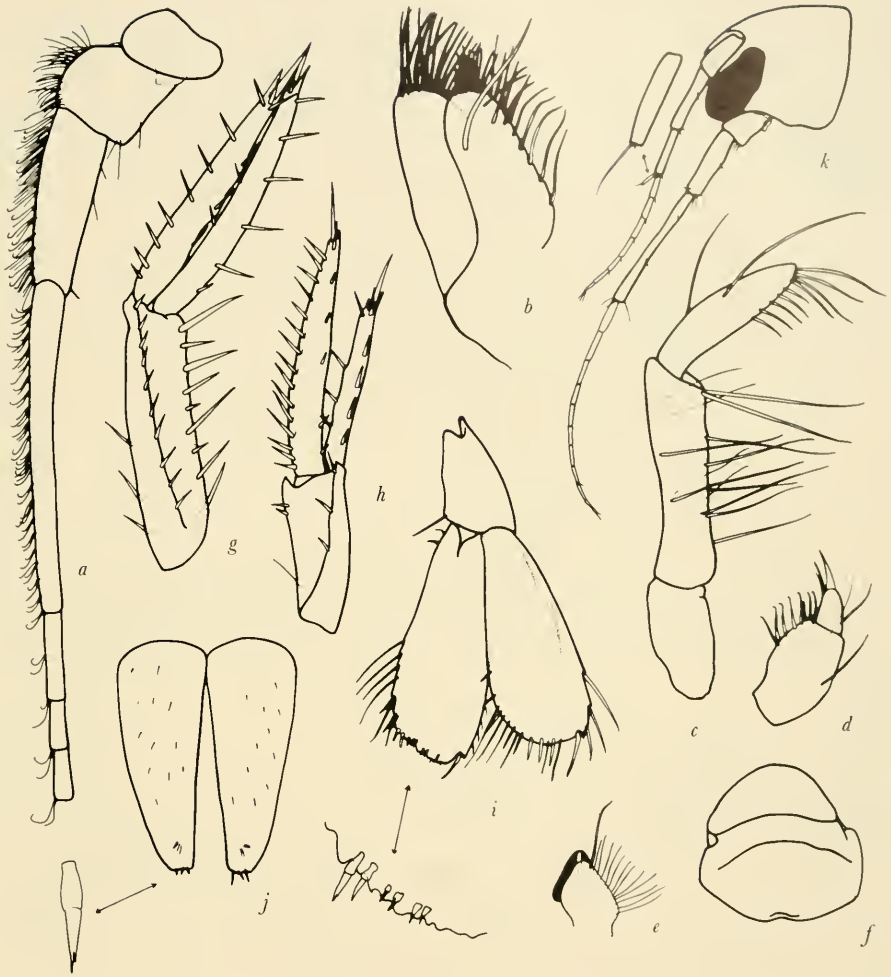

Figure 19. **Megaluropus visendus,** new species, male, 2.5 mm, BLA 9: a, antenna 2, flagellum cut after article 3; b, maxilla 2; c, mandibular palp; d, maxillipedal palp articles 3-4; e, inner plate of maxilla 1; f, upper lip. Female, holotype, 2.7 mm: g, h, i, uropods 1, 2, 3; j, telson; k, head.

than other coxae, evenly rounded below, not tapering; coxae 5-7 unusually long, coxa 5 with long anterior lobe projecting ventrally, coxa 6 with small anterior lobe projecting anteriorly, coxa 7 with anteroventral lobe; gnathopod 1 small, stout, simple, poorly setose, articles 4 and 5 rather bulbous, article 6 comparatively slender, dactyl armed with stout, partially fused, distal spine; gnathopod 2 of female with very slender second article bent proximally, article 4 small and not produced behind, article 5 triangular, long, with apex of triangle forming posterior process, article 6 linear, slender, simple, article 7 about two thirds as long as article 6, bearing 1 distal spine and several setules; gnathopod 2 of male with article 5 less triangular in shape, posterior process pointing distally, article 6 inflated but slender relative to article 5, tapering distally, without distinct palm, dactyl long, curved, about two thirds as long as palm and distally bearing fused spine without accessory setules; pereopod 2 longer than 1, but both otherwise similar, slender, article 6 shorter than 5; fifth articles of pereopods 3, 4 (? and 5), about half as long as fourth articles, these pereopods relatively shorter than in *Megaluropus agilis;* posterodorsal margins of pleonites 1 and 2 minutely serrate, segments 4 and 5 slightly elevated as in *M. longimerus* (as shown by Barnard, 1962b) and serrate; third pleonal epimeron evenly rounded behind, densely serrate, second pleonal epimeron subquadrate at posteroventral corner, with 2 distal serrations; first pleonal epimeron evenly convex behind, protuberant posteriorly, rounded-quadrate at ventral corner; telson long, reaching about to middle of rami of uropod 3, poorly armed.

Holotype. — USNM No. 111511, female, 2.7 mm.

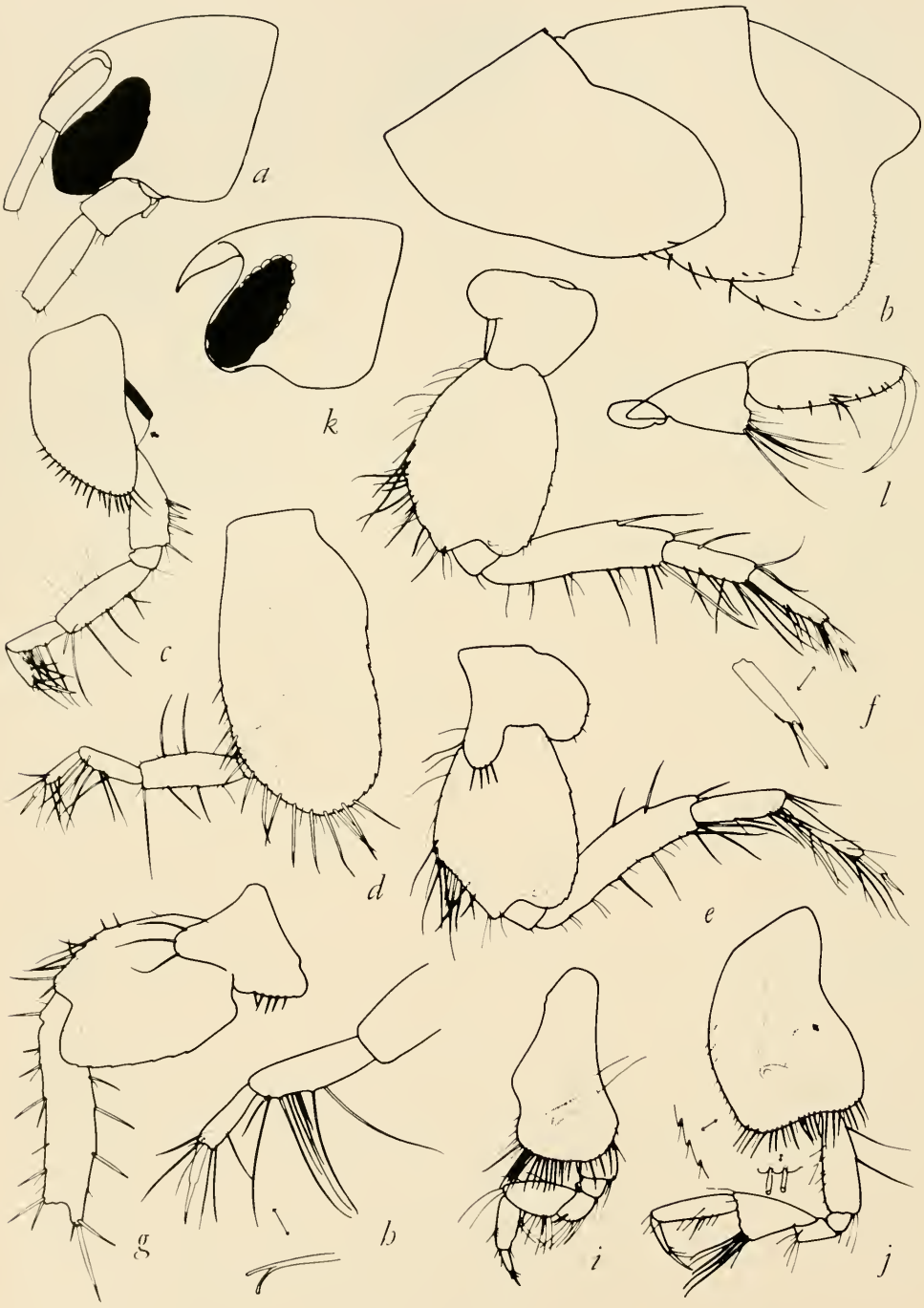

Figure 20. **Megaluropus visendus,** new species, female, 2.7 mm, holotype, BLA 9: a, head; b, pleonal epimera 1-3, left to right; c, d, e, f, g, pereopods 1, 2, 3, 4, 5; h, pereopod 2, enlarged; i, j, gnathopods 1, 2. Male, 2.5 mm: k, head; l, gnathopod 2. Arrows in figs. c and j indicate gill attachments.

Type-locality. — BLA 9, 2 m, October 31, 1963.
Relationship. — This species resembles *Megaluropus agilis* Hoek, as figured by Chevreux and Fage (1925) but has numerous small differences: (1) the rostrum is narrower, longer, and more discrete; (2) the heads of both sexes are similar and the eyes are of the same large size, in contrast to the small female eyes of *M. agilis;* (3) article 5 of second antennal peduncle is much longer than article 4; (4) the accessory flagellum is uniarticulate; (5) coxa 1 is broader and coxae 4-7 are longer and of different shapes than in *M. agilis;* (6) gnathopod 2 of the female is somewhat similar to that of *M. agilis* but article 5 is broader and article 6 more evenly slender; (7) gnathopod 2 of the male has article 5 much broader and with a distinct posterior lobe; (8) pereopods 3-5 are shorter and article 5 is much shorter than in *M. agilis.*

Dorsal serrations either occur or do not occur on pleonites 1-2 in the present material.

The gnathopodal differences of these two species indicate that the specimens identified by Barnard (1964a) as *M. agilis* are in reality a new species. That identification was based on a scant material with high variability but the following differences from *M. agilis* as figured by Chevreux and Fage (1925) now appear significant: (1) broader first coxa; (2) the distinctly triangular shape, posterior lobation and greater breadth of article 5 on male gnathopod 2 and the longer dactyl; (3) the more discrete rostrum of the male; (4) the distinctive female second gnathopod which is like the first gnathopod in the new species; but in *M. agilis* the first gnathopod has a broader fifth article with a distinctly subtriangular shape, whereas in *M. agilis* of Barnard the article is a linear trapezoid; (5) the uniarticulate accessory flagellum.

There are sufficient distinctions between the descriptions of *M. agilis* by Chevreux and Fage (1925) and by Pillai (1957) to suggest that the latter Indian material is also a new species.
Records. — Ranging in depth from 2 to 17 m on coarse to fine sand.

Melita sulca (Stout)

Caliniphargus sulcus Stout, 1913: 641-642.

Shoemaker (1941) relegated this species to *Melita palmata* (Montagu) but unlike that species, at least as figured by Sars (1895), the second urosomal segment of *Melita sulca* bears two pairs of small cusps, each pair embracing a seta, whereas *M. palmata* has a single dorsolateral cusp on each side.
Records. — Rocky intertidal to 24 m in the offshore islands and north of the village sandspit.
Distribution. — Southern California intertidal.

Meximaera, new genus

Diagnosis.— Antenna 1 with 4-articulate accessory flagellum; article 2 of mandibular palp longer than either articles 3 or 1, article 3 slender, linear (not falcate); lower lip bearing inner lobes; inner plate of maxilla 1 setose only terminally; inner plate of maxilla 2 scarcely setose on medial edge, considered primarily to be setose terminally; article 4 of maxillipedal palp not claw-shaped, short, bearing several long, distal spine-setae; gnathopods small but distinctly subchelate; uropod 3 with subequal rami, outer minutely biarticulate; telson cleft.
Type-species. — **Meximaera diffidentia,** new species.
Relationship. — Differing from *Maera* Leach by the short, non-unguiform article 4 of the maxillipedal palp and the strongly biarticulate outer ramus of uropod 3. The general aspect of *Meximaera* resembles that of *Maeracunha* Stephensen (1949), from Tristan da Cunha. The two genera have truncate antero-lateral cephalic margins and biarticulate outer rami of uropod 3, but *Meximaera* differs from *Maeracunha* in the poorly or non-setose medial edges of the inner lobes of both pairs of maxillae. *Meximaera* differs from *Maeropsis* Chevreux (1927) and *Paraceradocus* Stebbing (see 1906) in the poorly setose medial edge of maxilla 2 and the biarticulate outer ramus of uropod 3. The above-two genera may be synonymous. *Maerella* Chevreux (1911) has a triarticulate maxillipedal palp.

This genus appears to be a derivative of the *Maera*-line with the retention (primitive) of a second article on the outer ramus of uropod 3 and the rare occurrence of a shortened fourth maxillipedal palp article.

Meximaera, like *Linguimaera* Pirlot (1936), has the anteriorly lobate lip which also is common to several species of *Maera* and caused Schellenberg (1938) to synonymize *Linguimaera* with *Maera.* The identifications of *M. othonides* Walker (1904), the type-species of *Linguimaera,* are confused. Pirlot (1936) discounted Chilton's (1921) and K. H. Barnard's (1935) identifications and Nayar (1959), who did not cite Pirlot (1936), has identified material with *M. othonides* which fails to correspond with Pirlot's. Until valid specimens of Walker's species can be reexamined minutely for a second article on the outer ramus of the third uropod and for its maxillipedal palp article 4, there remains the possibility that *Meximaera* and *Linguimaera* are synonymous. If so, *Linguimaera* should be revived and take precedence over *Meximaera.*

Meximaera diffidentia, new species

Figures 21, 22

Diagnosis. — With the characters of the genus.
Notes. — The sides of the head are almost without lobular differentiation. The dactyls of the pereopods are complexly armed (see figures). Article 1 of antenna 1 has a ventral, proximal spine. The medial palmar surface of gnathopod 2 has not only a pair of marginal defining spines but a large submarginal spine dominating the palm. Female unknown.

Figure 21. **Meximaera diffidentia,** new genus, new species, male, holotype, 5.8 mm, BLA SIO-62-216: a, head; b, c, gnathopod 1, lateral and medial views; d, gnathopod 2; e, maxilliped; f, g, h, uropods 1, 2, 3; i, pleonal epimera 1-3, left to right.

Holotype. — USNM 111497, male, 5.8 mm.
Type-locality. — BLA SIO-62-216, reef between Isla Ventana and Isla Cabeza de Caballo, shore, tailings of fish sample, April 21, 1962, Dr. Carl L. Hubbs and party, coll.
Records. — Rocky intertidal to 24 m in the offshore islands.

Family Haustoriidae

Platyischnopus metagracilis Barnard

Platyischnopus metagracilis Barnard, 1964a: 225-226, fig. 3.
Records. — Ranging in depth from 13 to 46 m, more abundant in 20-46 m, frequency in April in latter depths is 170 individuals/m^2, in October, 26/m^2.
Distribution. — Punta Canoas to Bahía de San Cristóbal, Baja California, 30-73 m.

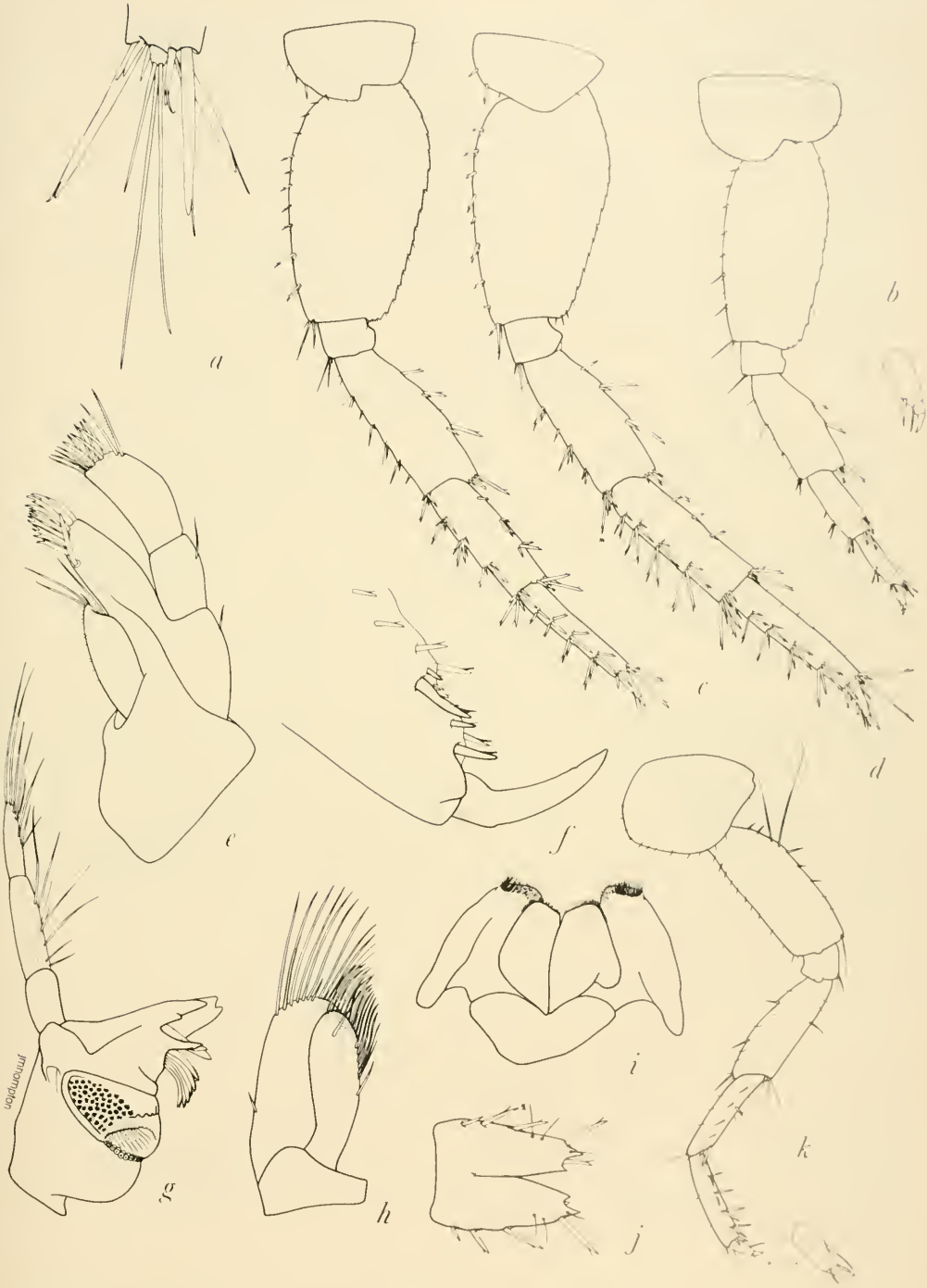

Figure 22. Meximaera diffiidentia, new genus, new species, male, holotype, 5.8 mm, BLA SIO-62-216: a, tip of outer ramus of uropod 3 showing article 2; b, c, d, pereopods 3, 4, 5; e, maxilla 1; f, gnathopod 2, medial surface of palm; g, mandible; h, maxilla 2; i, lower lip; j, telson; k, pereopod 1.

Platyischnopus viscana Barnard

Platyischnopus viscana Barnard, 1964a: 226, fig. 4.
Record. — Rocky intertidal of offshore islands.
Distribution. — La Jolla, California to Bahía Magdalena, Baja California, 17-27 m.

Family Hyalidae

Hyale rubra frequens Stout

Allorchestes frequens Stout, 1913: 650-651.
Hyale rubra (Thomson). Hurley, 1957: 910-913, figs. 30-50.
Hyale nigra (Haswell). Barnard, 1962c: 153-156, figs. 19, 20.
Hyale rubra frequens Barnard (in press).

Specimens from BLA have the elongate antennae typical of specimens from Bahía de San Quintín (Barnard, 1964b) and the setae on the posterior edge of the hand on male gnathopod 1 are widely spread; they occupy 30 percent of the marginal length.
Records. — Rocky intertidal to 7 m.
Distribution. — California and Baja California, intertidal.

Family Isaeidae (=Photidae)

Amphideutopus oculatus Barnard

Amphideutopus oculatus Barnard, 1959a: 34-35, pl. 10; 1961: 181, fig. 2; 1964a: 236; 1964b: 110, chart 15.
Records. — Rocky intertidal of offshore islands; 9-16 m in dredge haul; all other samples in depths of 22-41 m primarily on brown silty sands.
Distribution. — Pt. Conception, California to Bahía de San Cristóbal, Baja California, 2-162 m.

Eurystheus thompsoni (Walker)

Eurystheus tenuicornis var. *lobata* Shoemaker, 1942: 28, fig. 10 a-c.
Eurystheus thompsoni Shoemaker, 1955: 59.

Gnathopod 1 is typical of var. *lobata*, having the large, posterior, setose lobe on article 2.
Record. — Rocky intertidal of offshore islands.
Distribution. — Bahía Magdalena, Baja California (*lobata* variety).

Eurystheus tonichi, new species

Figure 23

Diagnosis. — Similar to *E. thompsoni* (Walker) (see Shoemaker, 1931, 1942, 1955) and in male undergoing similar radical transformation of gnathopod 2 and coxa 7; following characters similar to *E. thompsoni:* eyes and head, with slight anterior cusp on sharp lateral cephalic lobe; epistome strongly produced and acute, other mouthparts similar but setules on inner plate of first maxilla vrey fine; pleonal epimera 1-3 with tooth at posteroventral corners, third with very convex, nearly subacute, posterior edge (male holotype slightly aberrant, other specimens like Shoemaker, 1931, figure 4a); pleonites 4-5 with pairs of dorsolateral teeth similar to *E. thompsoni;* uropods similar, rami of uropod 3 slightly longer than peduncle, uniarticulate, inner slightly longer than outer; telson strongly excavate posteriorly, each lobe armed with 1 spine and setules. Characters distinct from *E. thompsoni:* gnathopod 1 with article 6 stouter, more inflated; fully adult male gnathopod 2 with palm and posterior margin of article 6 confluent, simple, distal end of palm with single cusp, dactyl folding halfway along posterior margin of article 6; young male gnathopod 2 similar to young male of *E. thompsoni* (compare fig. 23k herein and fig. 3a of Shoemaker, 1931).

Most of the specimens have lost pereopods 3-5 but this does not detract from the several specific characters distinguishing this species from *E. thompsoni.* Pereopods 4-5 of the holotype and of a young male are very small and may be regenerate. Article 2 of pereopod 4 on the young male is narrow and posteriorly sinuous.

Female almost identical with that of *E. thompsoni,* specimens from California being compared with those of Bahía de Los Angeles (figures 23 n, o herein for gnathopod 2).
Holotype. — USNM No. 111472, male, 5.3 mm.
Type-locality. — BLA 212, west shore of Bahía de Los Angeles, west of Isla Ventana, dredge of *Ulva* and gracilarioids, sand bottom, 9-16 m April 28, 1962.
Relationship. — Differs conspicuously from *E. thompsoni* by the simple palm of the terminal adult male, having a single cusp; in *E. thompsoni* the palm is distally subtransverse, short and armed with 2 cusp-teeth, one of them defining the palm. Pereopod 3 of *E. tonichi* apparently does not differ from that of *E. thompsoni* except by the slightly broader article 2.
Records. — Rocky intertidal to 38 m on shell sands.

Photis ?bifurcata Barnard

?Photis bifurcata Barnard, 1962a: 30-31, fig. 10; 1964a: 240.

Specimens are subadult but presumably represent this unusual species.
Records. — Ranging in depth from 38 to 46 m.
Distribution. — Monterey Bay, California to Bahia de San Cristóbal, Baja California, 11-93 m.

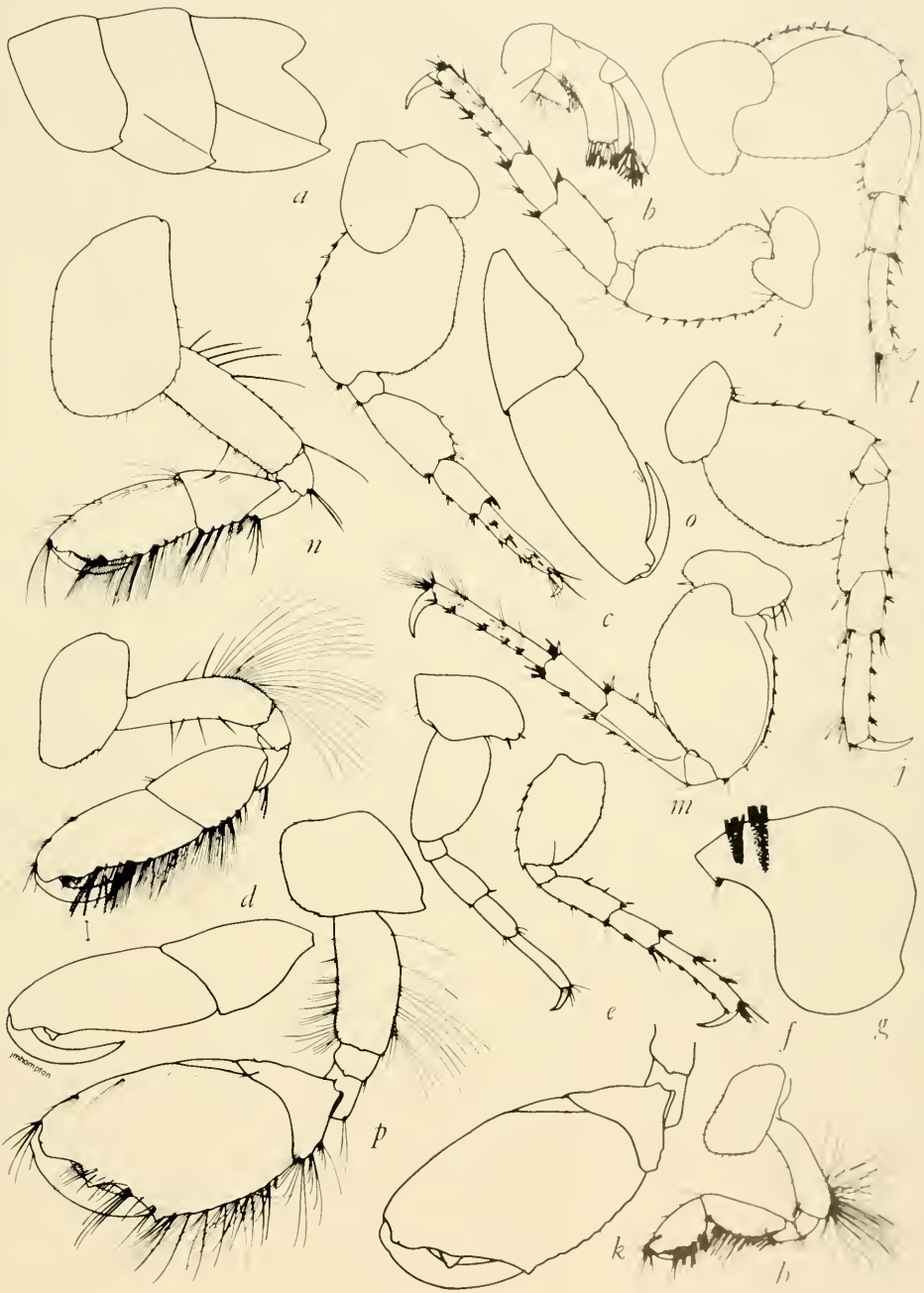

Figure 23. **Eurystheus tonichi,** new species, male, 5.3 mm, BLA 212: a, pleonal epimera 1-3, left to right; b, maxilla 1; c, pereopod 3; d, gnathopod 2, 2 views; e, f, pereopods 4, 5; g, coxa 7; h, gnathopod 1. Male, 4.5 mm, BLA SIO-62-215: i, j, pereopods 4, 5; k, gnathopod 2, lateral view minus setae. Male, 5.4 mm, BLA 212: l, m pereopods 3, 4. Female, 6.3 mm, BLA 212: n, o, gnathopod 2, 2 views. Male, 5.4 mm, BLA SIO-62-215: p, gnathopod 2, lateral.

Photis brevipes Shoemaker

Photis brevipes Shoemaker, 1942: 25-27, fig. 9. Barnard, 1962a: 31-33, fig. 11; 1964a: 240-241.

The two adult males of BLA 25 (3.0 mm) have the inner protuberance on article 7 of gnathopod 2 smaller and more proximal than in Californian specimens.

Records. — Ranging in depth from 9 to 36 m.

Distribution. — Coos Bay, Oregon to Bahía Magdalena, Baja California, 0-135 m.

Photis californica Stout

Photis californica Stout. Barnard, 1962a: 33-36, figs. 12, 13; 1964a: 241.

The male of BLA 144 (3.0 mm) has a well-developed lobe on article 2 of gnathopod 1, and the palm of the hand, similar to the female second gnathopod, is more excavate than in specimens from California.

Records. — Ranging in depth from 34 to 46 m.

Distribution. — Monterey Bay, California to Bahía de San Cristóbal, Baja California, 10-139 m.

Family Ischyroceridae

Jassa falcata (Montagu)

Jassa falcata (Montagu). Sexton and Reid, 1951: 30-47, pls. 4-30. Barnard, 1959a: 37; 1964b: 118.

Records. — Ranging in depth from 7 to 18 m.

Distribution. —Cosmopolitan in shallow waters and intertidal zones, especially in harbors on pilings.

Microjassa macrocoxa Shoemaker

Microjassa macrocoxa Shoemaker, 1942: 44-47, figs. 16, 17.

Records. — Rocky intertidal to 38 m, most abundant in shallow water dredge hauls.

Distribution. — Bahía Magdalena, Baja California, 18-27 m.

Family Leucothoidae

Leucothoe alata Barnard

Leucothoe alata Barnard, 1959a: 19-20, pl. 1; 1962c: 132, figs. 7 D, E, F; 1964a: 227.

Records. — Rocky intertidal of Vermilion Sea Field Station.

Distribution. — Monterey Bay, California to Bahía de San Ramón, Baja California, 0-24 m.

Family Liljeborgiidae

Liljeborgia marcinabrio, new species

Figure 24

Diagnosis. — Lateral cephalic lobes obtuse, strongly projecting; eyes large but poorly pigmented, ommatidia sparse; mandibular palp article 2 not exceeding article 1 in length; coxa 1 barely expanded distally, coxa 2 strongly beveled anterodistally, coxa 4 sparsely serrate posteriorly, corner at excavation rounded, not sharp; article 4 of both gnathopods acutely produced and slightly attenuate; dactyls of gnathopods 1 and 2 with 4 and 7 teeth on respective inner edges; serrations on second articles of pereopods 3-5 strongly demarcated; both margins of both rami of uropod 3 spinose; telson with apices of each lobe very deeply incised, resulting pair of cusps asymmetrical; posterodorsal edges of pleonites 1-2 each with 3 teeth, of pleonites 4-5 each with one large, posteriorly directed tooth, pleonite 3 lacking dorsal teeth; pleonal epimera 1 and 2 each with posteroventral tooth, third epimeron with bifid tooth.

Holotype. — USNM No. 111504, female, 5.4 mm. Unique.

Type-locality. — BLA 138, 46 m, April 22, 1962, brown silt.

Relationship. — This species, having the aspect of *Liljeborgia kinahani* (Bate) (see Sars 1895: pl. 188, fig. 1), differs by the larger, poorly pigmented eyes, the strongly spinose rami of uropod 3, the bifid tooth of pleonal epimeron 3, the slightly more expanded first coxa but more strongly beveled second, by the rounded cephalic lobe and the larger, less disproportionate teeth of pleonites 4-5.

In terms of dorsal pleonal tooth-formulas this species has the following relatives, each of which is listed with its distinctions: *L. aequabilis* Stebbing (in Hurley, 1954) has a single posteroventral tooth on the third pleonal epimeron, less strongly notched telsonic apices, a denser comb of spines on article 6 of pereopods 1-2, a smooth posterior edge of coxa 4; *L. akaroica* Hurley (1954) has a single tooth on the posteroventral corner of the third pleonal epimeron, and larger teeth on pleonites 4-5; *L. longicornis* (Schellenberg, 1931) has only a simple notch on the third pleonal epimeron and a broadly expanded first coxa, its peculiar dactyl of pereopod 5 not being compared to the new species because of the loss of pereopods in the unique specimen; *L. macrodon* Schellenberg (1931) again has the simply-notched third pleonal epimeron and obsolescent medial cusps of the telsonic apices; both *L. mixta* Schellenberg (1925) and *L. octodentata* Schellenberg (1931) differ from *L. marcinabrio* by their simple third epimeral tooth and sinus.

Liljeborgia marcinabrio bears a remarkable resemblance to *L. hansoni* Hurley (1954), from New Zealand, in pleonal epimera, telson, pereopods, and except for pleonite 1, the dorsal sculpture. Pleonite 1 of *L. hansoni* has only a single medial tooth. Its second mandibular palp article is longer than the first.

Listriella melanica lazaris, new subspecies

Figure 26 c-g

References to the nominate subspecies are as follows: Barnard, 1959b: 16-18, figs. 1, 2; 1964a: 229; 1964b: 108, chart 8.

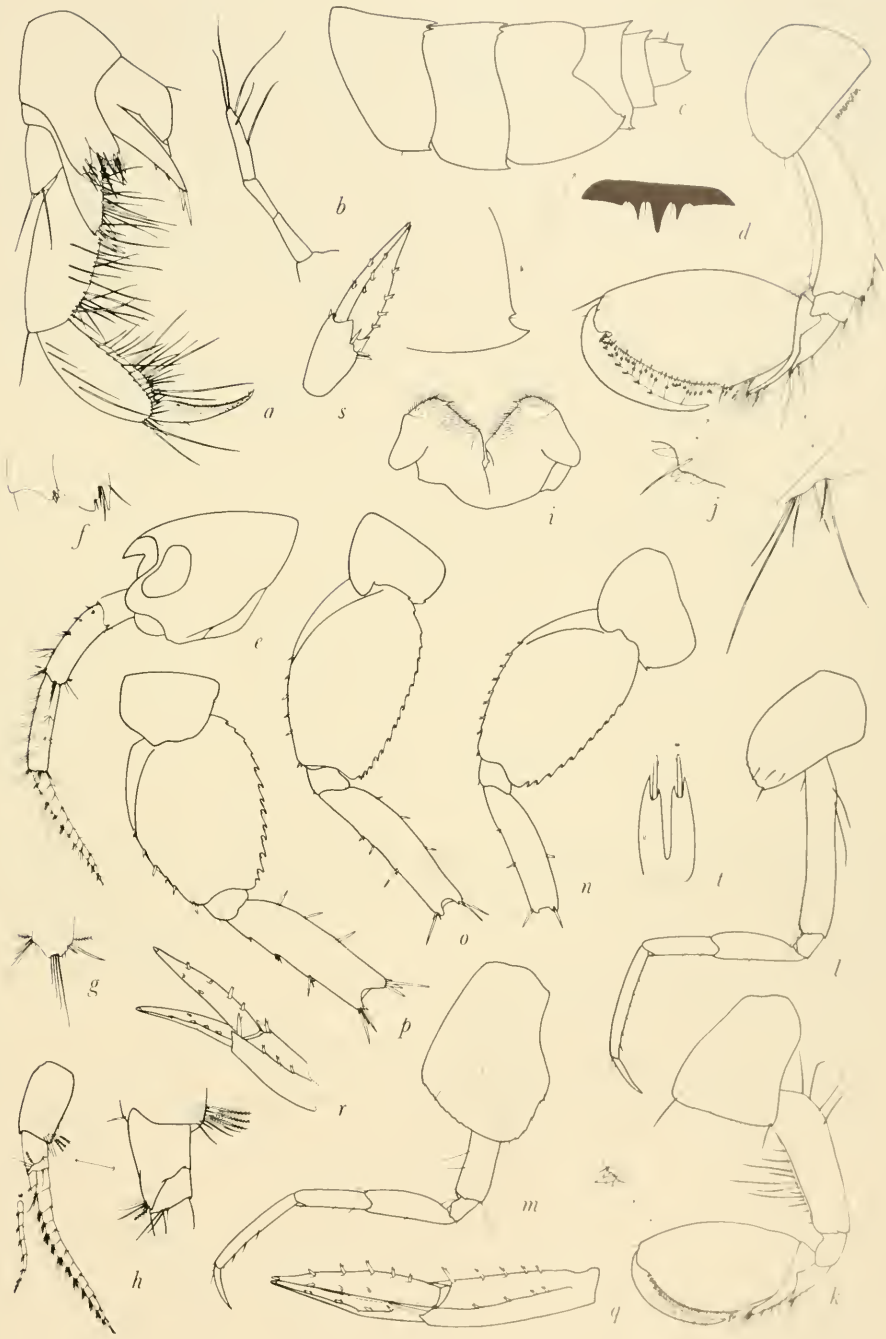

Figure 24. **Liljeborgia marcinabrio,** new species, female, 5.4 mm, BLA 138: a, maxilliped; b, mandibular palp; c, pleon; d, dorsum of pleonites 1-2 (a single example); e, head; f, end of article 3 of antenna 2, 2 views; g, end of article 4 of antenna 2; h, antenna 1; i, lower lip; j, k, gnathopods 2, 1; l, m, n, o, p, pereopods 1, 2, 3, 4, 5; q, r, s, uropods 1, 2, 3; t, telson.

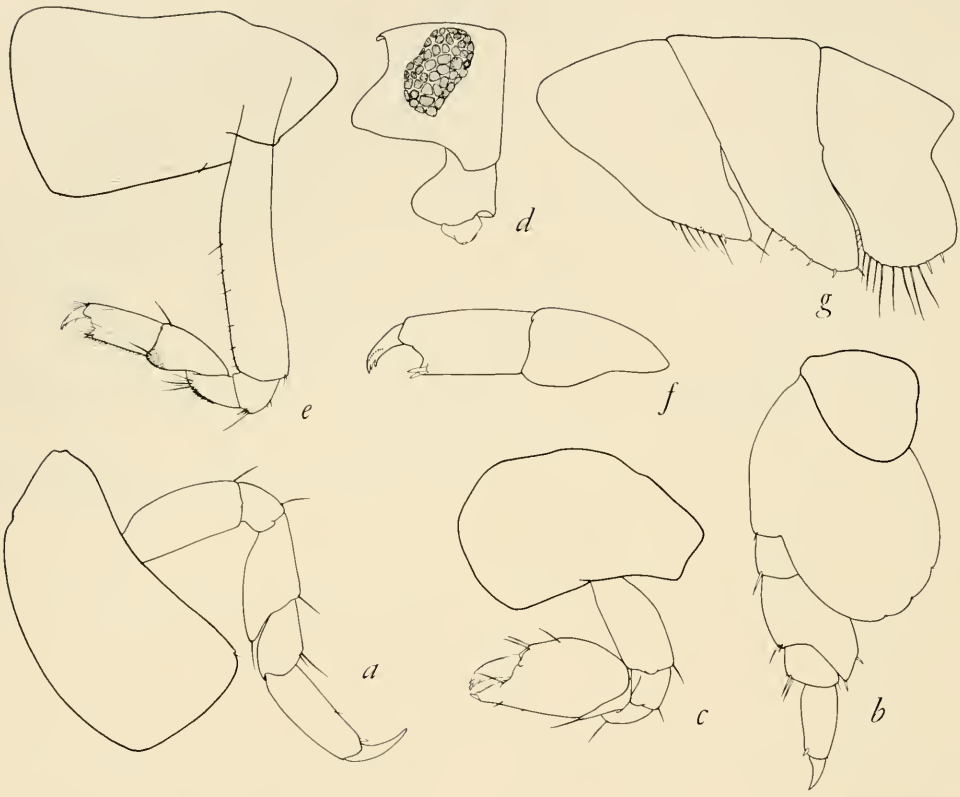

Figure 25. **Pachynus barnardi** Hurley, female 1.8 mm, BLA 97: a, b, pereopods 1, 5; c, gnathopod 1. *Orchomene magdalenensis* (Shoemaker), male, 3.7 mm, BLA 142: d, head; e, f, gnathopod 1. *Polycheria osborni* Calman, ovigerous female, 5.6 mm, BLA 214: g, pleonal epimera 1-3, left to right.

Diagnosis. — Female differing from female of nominate subspecies by distally expanding sixth article of gnathopod 1; this structure is similar in males of both subspecies.
Holotype. — USNM No. 111481, female, 3.2 mm.
Type-locality. — BLA 132, 25 m, April 22, 1962, bottom of shell sand.
Records. — Ranging in depth from 7 to 44 m; generally more abundant between 13 to 40 m; frequency of 39 individuals/m^2 in latter depths in April.
Distribution of *L. m. melanica*. — Pt. Conception, California to Bahía de San Cristóbal, Baja California, 12-97 m in the open-sea, 2-3 m in Bahía de San Quintín.

Family Lysianassidae
Hippomedon ?propinquus Sars
Figure 7 k, l, m, n

?Hippomedon propinquus Sars, 1895: 57, pl. 21, fig. 1. Gurjanova, 1962: 107-111, figs. 24-26 (with references). Barnard 1964b: 80-82 (as *H. denticulatus* and *H. propinquus*).

These subadult specimens lack the notch on pleonal epimeron 3 characteristic of the *H. denticulatus* group of species but Barnard (1964b) has presented evidence questioning that character as specifically significant. The specimens from BLA differ from *H. p. propinquus* in Gurjanova (1962) in the non-chelate palm of gnathopod 2 (fig. 7 k, l) and in this character the specimens resemble those from southern California and Bahía de San Quintín. Gnathopod 2 of BLA specimens differs from *H. p. sibiricus* in the shape of the palm and the short curved dactyl. Article 1 of the flagellum on antenna 1 is shortened (fig. 7n) in contrast to *H. p. sibiricus* Gurjanova (1962) and *H. p. propinquus*.
Records. — Ranging in depth from 15 to 30 m on silt and coarse sand.
Distribution. — The species occurs throughout the subarctic and boreal regions.

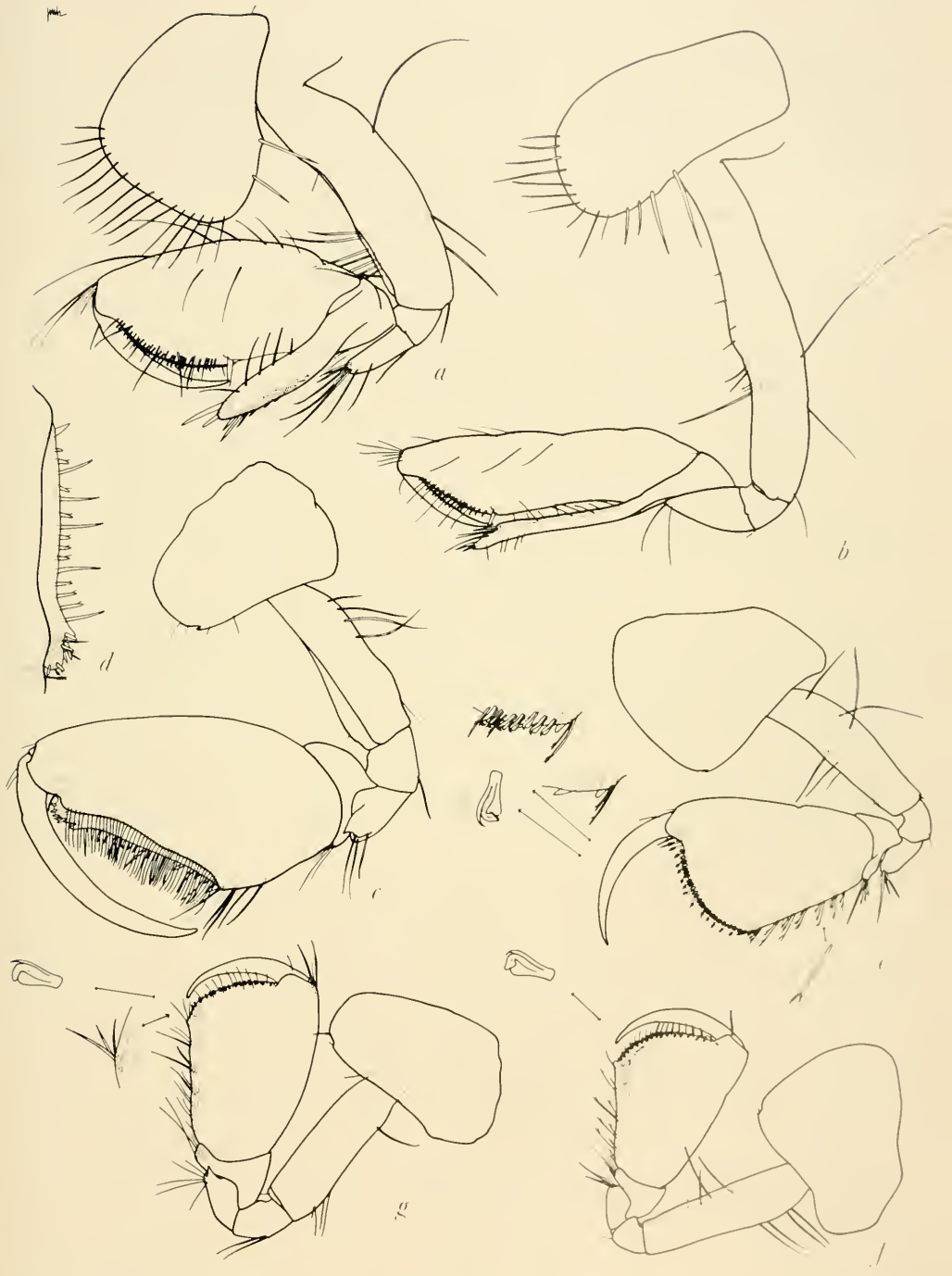

Figure 26. *Monoculodes hartmanae* Barnard, female, 4.6 mm, BLA 55: a, b, gnathopods 1, 2. *Listriella melanica lazaris* Barnard, new subspecies, male, 3.6 mm, BLA 132: c, gnathopod 2; d, palm of gnathopod 2; e, gnathopod 1 with offset spines and portion of palm. Female, 3.2 mm: f, g, gnathopods 1, 2.

Lysianassa dissimilis (Stout)

Nannonyx dissimilis Stout, 1913: 638-639.
Aruga dissimilis. Shoemaker, 1942: 7, fig. 2. Barnard, 1955b: 100-103, pl. 29, figs. g, i.
Lysianopsis dissimilis. Hurley, 1963: 76-77, fig. 21d.
Lysianassa dissimilis. Barnard (in press).
Record. — Rocky intertidal, island reef.
Distribution. — Coast of California from Tomales Bay to Isabel Island, México and the Galápagos Islands, 0-73 m.

Lysianassa macromerus (Shoemaker)

Aruga macromerus Shoemaker, 1916: 157-158.
Lysianopsis macromerus Hurley, 1963: 77.
Lysianassa macromerus Barnard (in press).
Record. — Rocky intertidal, Vermilion Sea Field Station.
Distribution. — Intertidal of southern California.

Orchomene magdalenensis (Shoemaker)

Figure 25 e, f

Orchomenella magdalenensis Shoemaker, 1942: 4-7, fig. 1.
Orchomene magdalenensis. Barnard, 1964a: 231-232; 1964b: 95, fig 12.

The male has a large, projecting, lateral cephalic lobe like that of the female, in contrast to the male described by Barnard (1964b) from Bahía de San Quintín. The first gnathopod of the male but not the female is strongly excavate in contrast to both Barnard's and Shoemaker's drawings (see figure herein). The female from Bahía de Los Angeles has the fourth pleonite similar to that of males, unlike outer-coast specimens.
Records. — Ranging in depth from 6 to 46 m.
Distribution. — Bahía de San Ramón to Bahía Magdalena, Baja California, 2-11 m.

Pachynus barnardi Hurley

Figure 25 a-c

Pachynus barnardi Hurley, 1963: 31-25, figs. 6, 7.

Only a few small specimens, approximately 1.8 mm in length have been collected in this survey. These differ from the original description in the stouter and shorter sixth articles of pereopods 3-5 and the somewhat stouter and shorter fifth article of gnathopod 2.
Records. — Ranging in depth from 30 to 46 m.
Distribution. — Monterey Bay, California to Bahía de San Ramón, Baja California, 12-183 m.

Uristes entalladurus Barnard

Uristes enalladurus Barnard, 1963: 460-462, figs. 5, 6; 1964b: 100.

The third pleonal epimeron is somewhat more quadrate and article 5 of gnathopod 2 more bulbous than in specimens from southern California.
Record. — Silty sand, 38 m.
Distribution. — Port Hueneme, California to Bahía de San Quintín, Baja California, 2-18 m.

Family Oedicerotidae

Monoculodes hartmanae Barnard

Figure 26 a, b

Monoculodes hartmanae Barnard, 1962d: 363-365, figs. 5-7.

Although *Monoculodes nyei* Shoemaker (1933a and see Barnard, 1962d) was expected from Bahía de Los Angeles, because of its occurrence at San Felipe to the north of Bahía de Los Angeles, all of the specimens of the genus collected in the latter bay belong to *M. hartmanae,* as shown in the accompanying drawings of gnathopods 1 and 2.
Records. — Rocky intertidal to 41 m but generally better represented between 13 and 38 m; frequency in the latter depths in April is 51 individuals/m^2.
Distribution. — Pt. Conception, California to Bahía de San Quintín, Baja California, about 2 to about 146 m but scarce in waters deeper than 37 m.

Synchelidium rectipalmum Mills

Synchelidium rectipalmum Mills, 1962: 17-19, figs. 5, 6B.
Records. — Rocky intertidal to 24 m on coarse substrate.
Distribution. — British Columbia to Costa Rica (specimens at hand), intertidal to 100+ m.

Synchelidium sp. G

This apparently new species is filed in Hancock and Smithsonian collections with this label; a study of this genus is in preparation.
Records. — Ranging in depth from 42 to 46 m.
Distribution. — Coastal shelf of southern California.

Westwoodilla cornuta, new species

Figures 27, 28

Description of female. — Rostrocephalon long, not strongly vaulted above, no distinct minute rostrum appended, anterior end of head slightly downturned and armed with 2 small setae, eyes apically located in distal half of rostrocephalon, small, eosin in color, anterolateral cephalic lobe sharp, symmetrical; article 1 of antenna 1 stout, produced dorsodistally into long, acute cusp, article 2 equal to 1, article 3 about 60 percent as long as article 2; antenna 1 reaching nearly to end of peduncular article 5 of antenna 2, the latter as long as head and pereon together, article 5 varying from 0 percent to 33 percent longer than article 4, flagellum as long as peduncle; epistome broadly and subacutely produced forward; upper lip broader than in *W. caecula* (in Sars, 1895: pl. 115) mandibular incisor simple, blunt, both sides with lacinia mobilis and 3 spines, molar short, very broad, blunt, flat, nearly smooth, bearing single short stout seta either simple or irregularly inflated in animals about to molt; palp article 2 proximally expanded and densely armed with stout setae; lower lip with rather narrow but curled mandibular lobes; palp article 2 of maxilla 1 broad, distally expanding; outer lobe of maxilla 2 narrower than inner lobe; inner plates of maxilliped much narrower than in other species of *Westwoodilla;* all anterior coxae with posteromedial spine, coxa 4 narrow for the genus, coxa 1 very broadly expanded; gnathopods small, scarcely subchelate, sixth articles narrow, fifth articles lacking posterior lobes (slightly better developed in gnathopod 1 of young specimens), gnathopod 2 longer and more slender than gnathopod 1; telson apically truncate, with slight lateral notches; third pleonal epimeron strongly setose ventrally and posteriorly (poorly in juveniles 3.0 mm), epimera 1-2 ventrally setose.

Male. — Antenna 2 slightly longer than in female, article 3 of first antennal peduncle as long as article 2, both articles 2 and 3 stouter than in female.

Holotype. — USNM No. 111442, female, 4.9 mm.

Type-locality. — BLA 105, 38 m, April 28, 1962.

Relationship. — Apart from normal specific differences occurring in other taxa of the genus, this species has characters that might serve as criteria for a new subgenus: the produced epistome; the proximally expanded and very strongly spinose second article of the mandibular palp; the very broad, flat, and smooth mandibular molar; the somewhat different lower lip (fig. 27i); the distally expanding second article of the first maxillary palp; the narrower inner plates of the maxilliped and the narrower outer plates of maxilla 2.

Mandibles of Californian *Westwoodilla caecula* (also figured in Sars, 1895, but with differences noted herein that may be of specific value) are shown herein with a smaller, more projecting molar having distinct cutting cuspules and spines, plus a much larger callused area (similar to Sars, 1895; pl. 117, figure of *Bathymedon)* defining the primary cutting edge than are seen in the new species. Few mouthparts of other species of *Westwoodilla* have been figured, so comparisons are in order when taxonomists reexamine them.

Specifically, the cusp of article 1 on antenna 1 is sufficient for differentiation from other known species of *Westwoodilla.* Apparently the strongly setose pleonal epimera are unique in the genus. Coxa 4 is very narrow, coxa 3 is excavate posteriorly and the outer ramus of uropod 3 is conspicuously shorter than the inner ramus, all characters not heretofore found in *Westwoodilla.*

Records. — From 19 to 46 m, with a frequency in April of 6.0 individuals/m^2, primarily on silt and silty sand bottoms.

Family Phliantidae

Heterophlias seclusus escabrosa Barnard

Heterophlias seclusus escabrosa Barnard, 1962b; 79, fig. 5.

Record. — Rocky intertidal of Vermilion Sea Field Station.

Distribution. — The nominate subspecies occurs in the Dry Tortugas Islands off Florida (Shoemaker, 1933b: 250-252, figs. 4, 5). The subspecies *escabrosa* occurs in the eastern Pacific Ocean in southern California, intertidal to about 16 m.

Family Phoxocephalidae

Heterophoxus oculatus (Holmes)

Heterophoxus oculatus (Holmes). Barnard, 1960b: 320-324, pls. 59-61; 1964a: 242.

Most of the specimens from the October samples are either juveniles or the adult form heretofore known as *H. o. nitellus* Barnard (1960). *H. o. nitellus* Barnard (1960b) is probably a synonym of *H. o. oculatus.*

Records. — Rocky intertidal to 46 m, but rare in depths of less than 30 m; frequency in April at 30-46 m is 124 individuals/m^2, in October, 44 individuals/m^2, on silts with rare exception.

Distribution. — Puget Sound, Washington to Panamá, 13-1785 m, at 2 m in Bahía de San Quintín, Baja California.

Paraphoxus cognatus Barnard

Paraphoxus cognatus Barnard, 1960b: 233-235, pl. 24.

A specimen from Dillon Beach, California, is the first female of the species to be recorded. It is like the male except for typical dimorphic characters: medium sized eyes, short second antennae and the short inner ramus of uropod 3 which is about two thirds as long as the outer ramus. The epistomal cusp is as short as that figured by Barnard; this character plus the long fifth articles of the gnathopods continue

Figure 27. **Westwoodilla cornuta,** new species, female, 4.9 mm, BLA 105: a, head with epistome below; b, pleonal epimera 1-3 left to right; c, antenna 1; d, telson; e, f, uropods 1, 2. male, 2.9 mm, BLA 149: g, h, antennae 1 2. Female, 5.4 mm, BLA 122: i, lower lip; j, k, maxilla 1; l, maxilla 2; m, mandibular palp; n, mandibular body. Female, BLA 158: o, upper lip; p, q, diagrams of mandibles to show molars and differentiated portions of primary cutting edges. *Westwoodilla caecula* (Bate), southern California: r, s, body and portion of body of right and left mandibles showing molar and differentiated portions of primary cutting edge in contrast to *W. cornuta.*

Figure 28. **Westwoodilla cornuta,** new species, female, 4.9 mm, BLA 105: a, b, c, d, pereopods 2, 3, 4, 5 (latter reduced in size); e, coxa 3; f, g, gnathopods 1, 2; h, maxilliped.

Figure 29. **Paraphoxus gemmatus,** new species, female, 5.8 mm, holotype, BLA 102: a, b, c, d, pereopods 2, 3, 4, 5, setae not drawn on pereopod 4; e, gnathopod 1; f, g, gnathopod 2; h, telson; i, epistome; j, head, dorsal; k, l, m, uropods 1, 2, 3.

to be the principal differences separating the species from *P. similis* Barnard.
Record. — Coarse shell sand, 6 m.
Distribution. — Southern California, surface nekton to 325 m, rare. A single female of this species is in the collections of the Pacific Marine Station, Dillon Beach, near Tomales Bay, California.

Paraphoxus epistomus (Shoemaker)

Paraphoxus epistomus (Shoemaker). Barnard. 1960b: 205-209, pls. 6-8; 1964a: 243.
Paraphoxus lucubrans Barnard, 1960b: 212-218, pls. 12-14.
Record. — Gray sand, 9 m (*lucubrans* variety)
Distribution.— Western Atlantic Ocean, New Hampshire to South Carolina; eastern Pacific Ocean from Mendocino County, California to Panamá, 0-182 m.

Paraphoxus gemmatus, new species
Figure 29

Diagnosis of female. — Head with broad rostrum but constricted anterior to eyes; eyes medium in size; body broad and dorsally depressed; epistome acutely produced anteriorly; maxillipedal palp article 4 with small apical spine, one subterminal seta and one mesial seta; article 5 of gnathopods 1-2 longer than article 6, latter moderately broad and expanded distally, palm transverse; ratio of articles 5 to 6: gnathopod 1=14:11; gnathopod 2=13:11; articles 4-5 of pereopod 3 moderately expanded, narrower than article 2, article 6 shorter than 5, ratio of widths of articles 2, 4, 5, 6=52: 40: 45: 20; article 4 of pereopod 4 slightly broader than article 4 of pereopod 3, article 6 much longer than 5, ratio of widths of articles 2, 4, 5, 6=78: 45: 32: 13; article 2 of pereopod 5 broad, ratio of width to length about 9: 11, posterior edge of article 2 with 5 small, symmetrical teeth, sweep-point occurring near distal end of article 4, ventral edge broad, scarcely dipping anteriorly and slightly convex; remainder of pereopod 5 moderately stout, article 6 longer than 5; uropods stout, rami of uropod 1 shorter than peduncle, very stout, expanded proximally, strongly notched outer ramus with 3 marginal spines, inner with 2 large spines (shining like jewels), lateral margin of peduncle densely spinose, with 3 large proximal setae on lateral surface, inner margin with seta, 2 marginal spines and 1 large distal spine; uropod 2 with rami subequal to

Figure 30. **Garosyrrhoe disjuncta,** new species, female, 4.2 mm, BLA SIO-X: a, head; b, c, d, pereopods 3, 4, 5; e, f, articles 6-7 of gnathopod 2; g, h, articles 6-7 of pereopods 1, 2; i, j, articles 6-7 of gnathopod 1; k, pleonal epimera 1-3, left to right; l, dorsal ornamentation of pleonite 3; m, dorsal ornamentation of pereonite 7 and pleonites 1-2. Male, 3.0 mm: n, maxilla 1; o, inner maxillipedal plate; p, maxilliped.

peduncle, very strongly notched and stout (not fully flattened in lateral drawing), each ramus with stout spine; inner ramus of uropod 3 as long as outer ramus, both strongly setose; telson moderately broad, apices rounded, each with 1 spine and 1 setule; third pleonal epimeron like *P. epistomus* (see pl. 6 in Barnard, 1960b), but spines much stouter, gland cone similar.

Male. — With typical sexual difference in its large eyes, strongly setose uropod 3, long second antennae and the more broadly rounded, asymmetrical third pleonal epimeron. Uropod 1 with only 2 spines on each ramus, neither expanded as much as in female. Epistomal process well-developed.

Holotype. — USNM No. 111499, ovigerous female, 5.8 mm.

Type-locality. — BLA 102, 6 m, October 31, 1963.

Relationship. — This species is similar to *Paraphoxus heterocuspidatus* Barnard (1960b) but differs by the presence of an acute, anterior epistomal cusp, the even teeth of pereopod 5 (some specimens of *P. heterocuspidatus* also show this), the presence of a marginal spine on both rami of uropod 3 and more than one on each ramus of uropod 1, with the rami much stouter and more strongly notched than in *P. heterocuspidatus*.

A specimen from BLA-9, provisionally referred to this species, is a male with no epistomal process and a fifth pereopod more like that of *P. lucubrans* Barnard (1960b) than that of the female of *P. gemmatus*; uropod 1 and all other characters except pereopod 5 are like those of *P. heterocuspidatus*.

Records. — Ranging in depth from 2 to 9 m.

Paraphoxus spinosus Holmes

Paraphoxus spinosus Holmes 1905: 477-478. Kunkel, 1918: 76-78, fig. 13. Shoemaker, 1925: 26-27. Barnard, 1959a: 18; 1960b: 243-249, pls. 29, 31; 1961: 178; 1964b: 105.

These specimens are like those from Newport Bay, California figured by Barnard (1960b).

Records. — Rocky intertidal to 24 m on coarse substrate.

Distribution. — Western Atlantic Ocean; eastern Pacific Ocean from Puget Sound to the Gulf of California, 0-37 m, rarely to 73 m.

Paraphoxus tridentatus (Barnard)

Pontharpinia tridentata Barnard, 1954c: 4-6, pls. 4, 5.

Paraphoxus tridentatus Barnard, 1960b: 261-262.

Paraphoxus tridentatus pallidus Barnard, 1960b: 262-263, pls. 38, 39.

These specimens are like those of *P. t. pallidus* figured by Barnard (1960b) but the rami of uropod 2 and the outer ramus of uropod 1 each lack the single spine characteristic of *P. t. pallidus*. The inner ramus of female uropod 3 is as long as article 1 of the outer ramus, whereas in *P. t. pallidus* the inner ramus is half as long as article 1 of the outer ramus. Gnathopods 1 and 2 are slightly stouter than in *P. t. pallidus*, more like those of the open-sea Oregonian form figured by Barnard (1954c).

Records. — Ranging in depth from 19 to 38 m.

Distribution. — Puget Sound, Washington to just north of Pt. Conception, California, shallow water and intertidal.

Family Pleustidae

Parapleustes commensalis Shoemaker

Parapleustes commensalis Shoemaker, 1952: 231-232, fig. 83.

This specimen, 4.0 mm long, corresponds to Shoemaker's figures and description, except that it is morphologically better-developed, even though it is 1.5 mm shorter. The inner plate of the maxilliped has 7 of the small blunt spines (not 4), the lateral margin of mandibular palp article 3 has 3 spines (not 2) and the gnathopodal palms have 3 sets (not 2) of double spines on the defining margins. Pleonal epimeron 3 is more strongly convex posteriorly than it is in Shoemaker's material.

Record. — Dredge, west side of bay at station 40, 9 m.

Distribution. — Santa Barbara, California, from pleopods of a spiny lobster.

Family Podoceridae

Podocerus brasiliensis (Dana)

Podocerus brasiliensis (Dana). Barnard, 1962a: 67, fig. 30; 1964a: 245-246.

Records. — Rocky intertidal to 24 m on coarse substrate.

Distribution. — Cosmopolitan in tropical and warm-temperate, shallow seas.

Podocerus fulanus Barnard

Podocerus sp., Barnard, 1959a: 40, pl. 14.

Podocerus fulanus Barnard, 1962a: 69.

Considerable variation occurs in the height of pereonal and pleonal dorsal teeth with large adults having these teeth projecting much more strongly than in Barnard's (1959a) figures. Large males have the palm of gnathopod 1 strongly concave.

Records. — Rocky intertidal to 42 m.

Distribution. — Newport Bay, California, about 0-2 m.

Family Synopiidae

Garosyrrhoe disjuncta, new species

Figure 30

Diagnosis. — Posterodorsal edges of pereonite 7 and pleonites 1-2 each with pair of blunt dorsolateral teeth,

each with medial hook and separated by shallow excavation, these teeth less prominent on pleonite 3, dorsolateral edges of these segments also with small hooked teeth; teeth of posterior edge of third pleonal epimeron much stronger than in *G. bigarra* (Barnard, 1962b); rostrum well-defined, acute, strongly projecting ventrally; article 5 of pereopod 3 about 80 percent as long as article 4, poorly setose posteriorly, article 2 bulging anterodistally.

Holotype. — USNM No. 111467, female-like, 3.0 mm.

Type-locality. — BLA SIO-X, Piedras Ahogadas, 0.5 mile south of Isla Ventana, SCUBA sample of shell fragments, pebbles, 24 m, April 22, 1962, Dr. Carl L. Hubbs and party, coll.

Relationship. — This species differs from *Garosyrrhoe bigarra* (Barnard, 1962b) by the longer, more acute rostrum, the double dorsal teeth of the body segments, the stronger teeth of the third pleonal epimeron and the shorter fifth article of pereopod 3. Pereopods 4 and 5 of *G. bigarra* are not known. Spination of articles 6-7 of pereopods 1-2 differs between the two appendages (see figures). The dorsal surface of the head bears a crest and the ventral surface of the inner maxillipedal plate bears a hooked spine. All the specimens are either females or lack brood-plates and have short second antennae and are therefore female-like.

Records. — Rocky intertidal to 24 m, usually on coarse substrate.

ACKNOWLEDGEMENTS

This report was supported in part by a National Science Foundation Grant (G-20909) and by the Beaudette Foundation of California. Mr. Richard F. Dwyer, of Los Angeles, California, has generously assisted with funds for publication. Miss Jacqueline M. Hampton prepared most of the plates. I gratefully acknowledge the assistance of numerous other persons listed by Barnard and Grady (1968). Mr. Scott Gray and Dr. Joel W. Hedgpeth, then of Pacific Marine Station, Dillon Beach, California, kindly loaned me a specimen of *Paraphoxus cognatus* for inclusion in this study. Mrs. Carolyn B. Gast prepared the charts.

LITERATURE CITED

ALDERMAN, A. L.
1936. Some new and little known amphipods of California. Univ. California Publ. Zool., 41: 53-74.

BARNARD, J. L.
1952. Some Amphipoda from Central California. Wasmann Jour. Biol., 10: 9-36.
1954a. Amphipoda of the family Ampeliscidae collected in the eastern Pacific Ocean by the *Velero III* and *Velero IV*. Allan Hancock Pacific Expeds., 18: 1-137.
1954b. Amphipoda of the family Ampeliscidae collected by the *Velero III* in the Caribbean Sea. Allan Hancock Atlantic Exped. Rept. 7: 1-13.
1954c. Marine Amphipoda of Oregon. Oregon State Monogs., Studies in Zool., 8: 1-103.
1955a. Gammaridean Amphipoda (Crustacea) in the collections of Bishop Museum. Bernice P. Bishop Mus., Bull. 215.
1955b. Notes on the amphipod genus *Aruga* with the description of a new species. Bull. S. California Acad. Sci., 54: 97-103.
1958. Index to the families, genera, and species of the gammaridean Amphipoda (Crustacea). Allan Hancock Found. Publs., Occ. Pap. 19: 1-145.
1959a. Estuarine Amphipoda. In Barnard, J. L., and D. J. Reish, Ecology of Amphipoda and Polychaeta of Newport Bay, California. Allan Hancock Found. Publs. Occ. Pap. 21: 13-69.
1959b. Liljeborgiid amphipods of southern California coastal bottoms with a revision of the family. Pacific Nat. 1(4): 12-28.
1960a. New bathyal and sublittoral ampeliscid amphipods from California, with an illustrated key to Ampelisca. Pacific Nat. 1(16): 1-36.
1960b. The amphipod family Phoxocephalidae in the eastern Pacific Ocean, with analyses of other species and notes for a revision of the family. Allan Hancock Pacific Expeds. 18: 175-368.
1961. Relationship of Californian amphipod faunas in Newport Bay and in the open sea. Pacific Nat. 2: 166-186.
1962a. Benthic marine Amphipoda of southern California: families Aoridae, Photidae, Ischyroceridae, Corophiidae, Podoceridae. Pacific Nat. 3: 1-72.
1962b. Benthic marine Amphipoda of southern California: families Tironidae to Gammaridae. Pacific Nat. 3: 73-115.
1962c. Benthic marine Amphipoda of southern California: families Amphilochidae, Leucothoidae, Stenothoidae, Argissidae, Hyalidae. Pacific Nat. 3: 116-163.
1962d. Benthic marine Amphipoda of southern California: family Oedicerotidae. Pacific Nat. 3: 349-371.
1962e. Benthic marine exploration of Bahia de San Quintin, Baja California, 1960-61. General. Pacific Nat. 3: 249-274.

1963. Relationship of benthic Amphipoda to invertebrate communities of inshore sublittoral sands of southern California. Pacific Nat. 3: 437-467.
1964a. Los anfipodos bentonicos marinos de la costa occidental de Baja California. Rev. Soc. Mexicana Hist. Nat. 24: 205-274.
1964b. Marine Amphipoda of Bahía de San Quintín, Baja California. Pacific Nat. 4: 55-139.
1965. Marine Amphipoda of the family Ampithoidae from southern California. Proc. U. S. Natl. Mus. 118: 1-46.
1966. Benthic Amphipoda of Monterey Bay, California. Proc. U. S. Natl. Mus. 119 (3541): 1-41.
In press. Intertidal gammaridean Amphipoda (Crustacea) of California: Monterey to La Jolla. Bull. U. S. Natl. Mus.

Barnard, J. L., and J. R. Grady
1968. A biological survey of Bahia de los Angeles, Gulf of California, Mexico. I. General account. San Diego Soc. Nat. Hist., Trans. 15: 51-66.

Barnard, K. H.
1935. Report on some Amphipoda, Isopoda, and Tanaidacea in the collections of the Indian Museum. Rec. Indian Mus. 37: 279-319.

Beltran, E., (Gen. Chm.)
1960. Symposium: The biogeography of Baja California and adjacent seas. Syst. Zool. 9: 47-91.

Calman, W. T.
1898. On a collection of Crustacea from Puget Sound. Ann. New York Acad. Sci. 11: 259-292.

Chevreux, E.
1908. Amphipodes recueillis dans les possessions francaises de l'océanie par M. le Dr. Seurat, directeur du laboratorie de recherches biologiques de Rikitea (îles Gambier). 1902-1904. Mém. Soc. Zool. France. 20: 470-527.
1911. Campagnes de la Melita. Les amphipodes d'Algerie et de Tunisie. Mém. Soc. Zool. France. 23: 145-285.
1927. Crustacés amphipodes. Expéd. Sci. "Travailleur" et du "Talisman" pendant les annés 1880, 1881, 1882, 1883. Malacostraces (suite). 9: 41-152.

Chevreux, E., and L. Fage
1925. Amphipodes. Faune de France. 9: 1-488.

Chilton, C.
1921. Report on the Amphipoda obtained by the F.I.S. "Endeavour" in Australian seas. Biol. Res. Fish. Exper. F.I.S. "Endeavour," 1909-14. 5: 33-92.

Garth, J. S.
1960. Distribution and affinities of the Brachyuran Crustacea. Syst. Zool. 9: 105-123.

Giles, G. M.
1888. No. 9. Further notes on the Amphipoda of Indian waters. Natural history notes from H. M.'s Indian marine survey steamer 'Investigator,' Commander Alfred Carpenter, R.N., D.S.O., commanding. J. Asiatic Soc. Bengal. 57: 220-225.

Gurjanova, E.
1951. Bokoplavy morei SSSR i sopredel'nyx vod (Amphipoda-Gammaridea). Opred. po Faune SSSR, Izd. Zool. Inst. Akad. Nauk. 41: 1-1031 (in Russian).
1962. Bokoplavy severnoi chasti Tixogo Okeana (Amphipoda-Gammaridea) chast' 1. Opred po Faune SSSR, Izd. Zool. Inst. Akad. Nauk. 74: 1-440 (in Russian).

Holmes, S. J.
1905. The Amphipoda of southern New England. Bull. U. S. Bur. Fish. 24: 459-529.

Hurley, D E.
1954. Studies on the New Zealand amphipodan fauna No. 9. The families Acanthonotozomatidae, Pardaliscidae and Liljeborjiidae. Roy. Soc. New Zealand. Trans. 82: 763-802.
1957. Studies on the New Zealand amphipodan fauna. No. 14 — The genera *Hyale* and *Allorchestes* (family Talitridae). Roy. Soc. New Zealand. Trans. 84: 903-933.
1963. Amphipoda of the family Lysianassidae from the west coast of north and central America. Allan Hancock Found. Publs. Occ. Pap. 25: 1-165.

Kunkel, B. W.
1910. The Amphipoda of Bermuda. Connecticut Acad. Arts Sci. Trans. 16: 1-116.
1910. The Arthrostraca of Connecticut. Connecticut Geol. Nat. Hist. Sur., Amphipoda, Bull. 6 (1): 15-181.

Mills, E. L.
1962. Amphipod crustaceans of the Pacific coast of Canada. II. Family Oedicerotidae. Nat. Hist. Paps. Nat. Mus. Canada. 15: 1-21.
1964. Noteworthy Amphipoda (Crustacea) in the collection of the Yale Peabody Museum. Postilla, Yale Peabody Mus. Nat. Hist. 79: 1-41.

NAGATA, K.
1960. Preliminary notes on benthic gammaridean Amphipoda from the *Zostera* region of Mihara Bay, Seto Inland Sea, Japan. Publ. Seto Mar. Biol. Lab. 8: 163-182.

NAYAR, K. N.
1959. The Amphipoda of the Madras Coast. Bull. Madras Govt. Mus., n.s. Nat. Hist. Sect. 6: 1-59.

PILLAI, N. K.
1957. Pelagic Crustacea of Travancore. III. Amphipoda. Bull. Cent. Res. Inst. Univ. Travancore, 5: 29-68.

PIRLOT, J. M.
1936. Les amphipodes de l'expédition du Siboga. Deuxiéme partie. Les amphipodes gammarides. II.—Les amphipodes de la mer profonde. 3. Addendum et partie générale. III. Les amphipodes littoraux. 1. Lysianassidae, Ampeliscidae . . . Siboga-Exped., Monog. 33e: 237-328.

SARS, G. O.
1895. Amphipoda. *In* An account of the Crustacea of Norway with short descriptions and figures of all the species. Christiania and Copenhagen. 1: i-viii, 1-711.

SCHELLENBERG, A.
1925. Crustacea VIII: Amphipoda. *In* Michaelsen, W., Beiträge zur Kenntnis der Meeresfauna Westafrikas, 3(4): 11-204.
1926. Die Gammariden der deutschen Südpolar-Expedition 1901-1903. Deutsch Südpolar-Exped. 18: 235-414.
1931. Gammariden und Caprelliden des Magellangebietes, Südgeorgiens und der Westantarktis. Further Zool. Res. Swedish Antarctic Exped. 1901-1903. 2 (6): 1-290.
1938. Litorale Amphipoden des tropischen Pazifiks. Kungl. Svenska Vetenskapakad. Handl., ser. 3. 16(6): 1-105.

SEXTON, E. W., and D. M. REID
1951. The life-history of the multiform species *Jassa falcata* (Montagu) (Crustacea Amphipoda) with a review of the bibliography of the species. J. Linnean Soc. London. 42: 29-91.

SHOEMAKER, C. R.
1916. Description of three new species of amphipods from southern California. Proc. Biol. Soc. Wash. 29: 157-160.
1925. The Amphipoda collected by the United States Fisheries steamer 'Albatross' in 1911, chiefly in the Gulf of California. Bull. Amer. Mus. Nat. Hist. 52: 21-61.
1926. Amphipods of the family Bateidae in the collection of the United States Museum. Proc. U. S. Natl. Mus. 68(2626): 1-26.
1930. The Amphipoda of the Cheticamp Expedition of 1917. Contr. Can. Biol. Fish. 5: 221-359.
1931. A new species of amphipod crustacean (Acanthonotozomatidae) from California, and notes on *Eurystheus tenuicornis*. Proc. U. S. Natl. Mus. 78 (2861): 1-8.
1933a. Amphipoda from Florida and the West Indies. Amer. Mus. Novitates. 598: 1-24.
1933b. Two new genera and six new species of Amphipoda from Tortugas. Papers Tortugas Lab., Carnegie Inst. Washington. 28(435): 245-256.
1934. Two new species of *Corophium* from the west coast of America. J. Wash. Acad. Sci. 24: 356-360.
1938. Three new species of the amphipod genus *Ampithoe* from the west coast of America. J. Wash. Acad. Sci. 28: 15-25.
1941. On the names of certain California amphipods. Proc. Biol. Soc. Washington 54: 187-188.
1942. Amphipod crustaceans collected on the presidential cruise of 1938. Smiths. Misc. Colls. 101 (11): 1-52.
1949. The amphipod genus *Corophium* on the west coast of America. J. Wash. Acad. Sci. 39: 66-82.
1952. A new species of commensal amphipod from a spiny lobster. Proc. U. S. Natl. Mus. 102: 231-233.
1955. Notes on the amphipod crustacean *Maeroides thompsoni* Walker. J. Wash. Acad. Sci. 45: 59.

SKOGSBERG, T., and G. H. VANSELL
1928. Structure and behavior of the amphipod, *Polycheria osborni*. Proc. Calif. Acad. Sci. ser. 4. 17: 267-295.

SOULE, J. D.
1960. The distribution and affinities of the littoral marine Bryozoa (Ectoprocta). Syst. Zool. 9: 100-104.

STEBBING, T. R. R.
1906. Amphipoda I. Gammaridea. Das Tierreich. 21: 1-806.
1910. Crustacea. Part 5. Amphipoda. Sci. Res. Trawling Exped. H.M.C.S. "Thetis." Australian Mus. Mem. 4 (2): 565-658.

STEPHENSEN, K.
1931. Crustacea Malacostraca. VII. (Amphipoda. III.). Danish Ingolf-Exped. 3:179-290.
1932. Some new amphipods from Japan. Annot. Zool. Japon 13: 487-501.

1935. The Amphipoda of N. Norway and Spitsbergen with adjacent waters. Tromso Mus. Skr. 3 (1): 1-140.
1940. Marine Amphipoda. Zool. Iceland. 3 (26): 1-111.
1944. Amphipoda. The Zool. of East Greenland. Medd. Grønland, 121 (14): 1-165.
1949. The Amphipoda of Tristan da Cunha. Res. Norwegian Sci. Exped. to Tristan da Cunha 1937-1938. 19: 1-61.

Stout, V. R.
1913. Studies in Laguna Amphipoda. Zool. Jahrb. Syst. 34: 633-659.

Walker, A. O.
1904. Report on the Amphipoda collected by Professor Herdman, at Ceylon, in 1902. Suppl. Rept. Ceylon Pearl Oyster Fisheries 1904. 17: 229-300.

Revised Manuscript Accepted for Publication 22 October 1968

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APPENDIX

Derivation of New Systematic Names

periculosus, L., perilous
susurrator, L., mutterer
coyoa, Sp., coyote
conductor, L., employer
Rildardanus tros; Ril, anagram from Lirondo, Sp., pure; Dardanus, mythical ancestor of royal family of Troy; Tros, grandson of Dardanus and son of Ericthonius.
nasa, L., fish-trap
luculenta, L., bright
falciformis, L., sickle-shaped, likeness
visendus L., gerundive of viso, contemplate
Meximaera diffidentia; Meximaera, a Mexican Maera; diffidentia, L., diffidence
tonichi, Mexicanization of L., tono, thunder; nidus, nest
marcinabrio, L., marcidus, perishable; abrir, Sp., to open
lazaris, Sp., lazar, to catch with lasso
cornuta, L., horn
gemmatus, L., bearing jewels
disjuncta, L., separation

S-NAS

A RECENT MOLLUSCAN FAUNA FROM THE CARIBBEAN COAST OF SOUTHEASTERN PANAMA

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OF THE SAN DIEGO
SOCIETY OF
NATURAL HISTORY

VOL. 15, NO. 14. 27 JUNE 1969

A RECENT MOLLUSCAN FAUNA FROM THE CARIBBEAN COAST OF SOUTHEASTERN PANAMA

George E. Radwin

Abstract. — This paper lists a Recent marine molluscan fauna from Payardi Island, Panama. Twenty-nine per cent of these species have close relatives on the Pacific side of the isthmus. It is suggested that the term "cognate" be used to replace the presently used term "analogue" in referring to these closely related forms.

Resumen. — En este artículo se incluye una lista de los moluscos recientes de la isla Payardi, Panamá. El veintinueve por cién de estas especies tienen parientes próximos en la parte del istmo correspondiente al Pacífico. Se sugiere que el término "cognado" reemplace al término "análogo" que luego esta usado en referencia a estas formas intimamente relacionadas.

The molluscan fauna of the Caribbean coast of Panama is of particular interest because, except for the paper of Olsson & McGinty (1958), it has been virtually unreported. The building of an oil refinery at Payardi Island, Republic of Panama, six

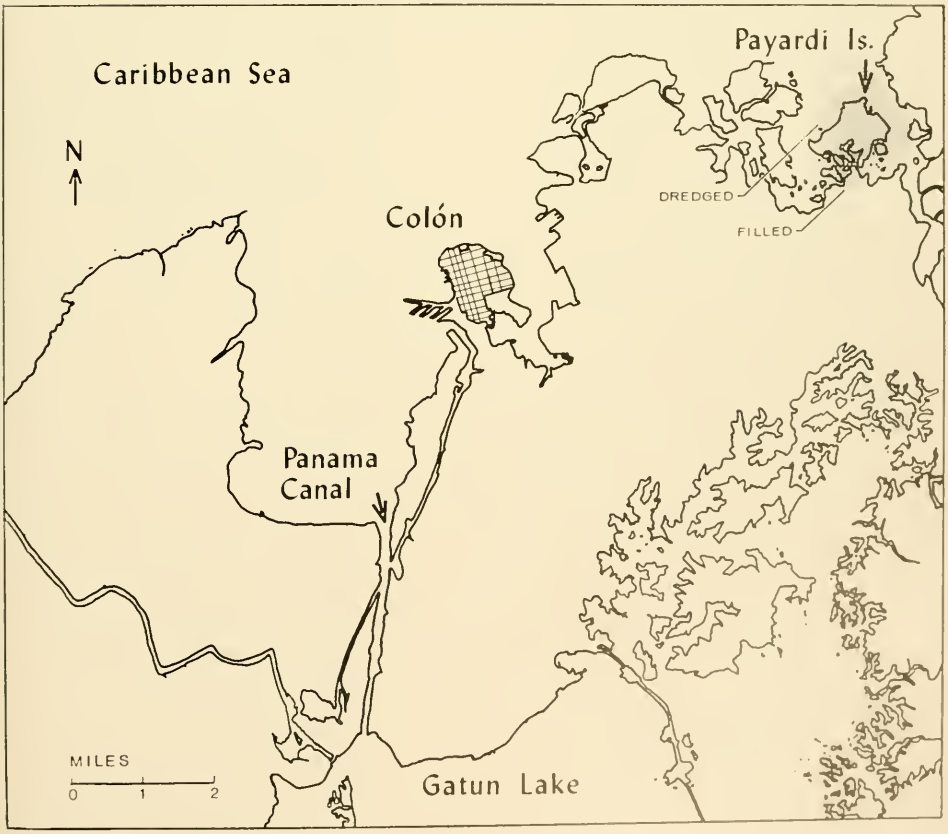

Figure 1. Location of the studied area in reference to Colon and the Panama Canal.

miles east of the city of Colón, (Fig. 1) from May, 1958 to August, 1959 provided an excellent opportunity to collect and record this fauna. During construction of the refinery material was dredged from the shoreward edge of a submerged coral reef and pumped into a marshy near-shore area to form a spoil bank. A representative series of mollusks was collected from this spoil by Messrs. Robert H. Stewart, Supervising Geologist, Panama Canal Co., and Anselmo Meña, and deposited in the U. S. National Museum. Most of this material is apparently of non-fossil origin and the Recent component forms the basis of this report.

Systematic List of Mollusks from Payardi Island, Panama

An asterisk signifies the existence of a cognate in the East Pacific (see Table 1).

GASTROPODA

PROSOBRANCHIATA

Scissurellidae
- *Woodwardia* sp.

Fissurellidae
- *Emarginula pumila* (A. Adams)
- **Hemitoma octoradiata* (Gmelin)
- **Diodora cayenensis* (Lamarck)
- *Diodora listeri* (Orbigny)
- *Lucapina suffusa* (Reeve)
- *Fissurella fascicularis* (Lamarck)
- *Fissurella nodosa* (Born)

Trochidae
- *Calliostoma euglyptum* (A. Adams)
- *Calliostoma javanicum* (Lamarck)
- *Cittarium pica* (Linne)
- *Tegula fasciatus* (Born)
- *Solariorbis schumoi* (Vanatta)
- *Solariorbis corylus* Olsson & McGinty
- *Solariorbis hondurasensis* (Vanatta)
- *Solariorbis infracarinata* (Gabb)
- *Solariorbis shimeri* (Clapp)
- **Anticlimax schumoi* (Vanatta)

Cyclostrematidae
- *Cyclostremiscus schrammi* (Fischer)
- *Cyclostremiscus jeannae* (Pilsbry & McGinty)
- *Pachystremiscus pulchellus* (Olsson & McGinty)

Turbinidae
- **Turbo castaneus* Gmelin
- *Turbo filosus* Wood
- *Astraea americana* (Gmelin)
- **Astraea caelata* (Gmelin)
- *Astraea phoebia* (Röding)
- *Liotia tricarinata* Stearns

Phasianellidae
- *Tricolia pulchella* (C. B. Adams)
- *Tricolia affinis cruenta* Robertson

Neritidae
- **Neritina virginea* Linné
- *Smaragdia viridis viridemaris* Maury

Architectonicidae
- **Architectonica nobilis* Röding
- **Heliacus perrieri* (Rochebrune)

Vermetidae
- *Vermetus varians* Orbigny
- *Aletes mcgintyi* Olsson & Harbison
- *Aletes nebulosus* (Dillwyn)
- *Aletes floridanus* Olsson & Harbison
- **Stephopoma myrakeenae* Olsson & McGinty
- *Spiroglyphus annulatus* Daudin
- *Thylacodes* sp.

Modulidae
- **Modulus modulus* (Linné)
- **Modulus carchedonius* (Lamarck)

Cerithiidae
- *Cerithium algicola* C. B. Adams
- **Cerithium litteratum* Born
- *Cerithium mocnense* Gabb
- **Cerithium variabile* C. B. Adams
- *Bittium varium* (Pfeiffer)
- *Alabina cerithioides* Dall
- **Litiopa melanostoma* Rang

Turritellidae
- *Turritella exoleta* Linné

Littorinidae
- *Littorina* sp.

Rissoidae
- *Rissoina cancellata* Philippi
- **Rissoina fischeri* Desjardin
- *Rissoina decussata* (Montagu)
- *Rissoa lipeus* Dall
- *Zebina browniana* (Orbigny)
- *Alvania aberrans* (C. B. Adams)
- **Alvania auberiana* (Orbigny)

Caecidae
- *Caecum imbricatum* Carpenter
- *Caecum heladum* Olsson & Harbison
- *Caecum ryssotitum* Folin
- **Caecum pulchellum* Stimpson
- *Caecum jucundum* Folin
- *Caecum clavum* Folin
- *Meioceras nitidum* Stimpson

Vitrinellidae
- *Cochliolepis striata* (Dall)
- *Episcynia inornata* (Orbigny)
- *Sansonia tuberculata* (Watson)
- *Parviturboides interruptus* (C. B. Adams)

TRIPHORIDAE
Triphora turristhomae Holten
Triphora nigrocincta C. B. Adams
CERITHIOPSIDAE
Cerithiopsis emersoni (C. B. Adams)
Cerithiopsis greeni (C. B. Adams)
Seila adamsi H. C. Lea
EPITONIIDAE
Epitonium foliacecostum Orbigny
Opalia crenata (Linné)
Depressiscala nautlae (Mörch)
EULIMIDAE
Eulima bifasciata (Orbigny)
Balcis intermedia (Cantraine)
FOSSARIDAE
Megalomphalus pilsbryi Olsson & McGinty
CALYPTRAEIDAE
Calyptraea centralis (Conrad)
**Crucibulum auriculum* (Gmelin)
Crepidula plana Say
Crepidula maculosa Conrad
Crepidula convexa Say
XENOPHORIDAE
**Xenophora conchyliophora* (Born)
STROMBIDAE
**Strombus pugilis* Linné
Strombus raninus Gmelin
ERATOIDAE
Trivia pediculus (Linné)
Trivia quadripunctata (Gray)
Erato maugeriae Gray
CYPRAEIDAE
Cypraea cinerea Linné
**Cypraea zebra* Linné
OVULIDAE
Cyphoma gibbosa (Linné)
NATICIDAE
**Natica canrena* (Linné)
Tectonatica Pusilla (Say)
**Polinices lacteus* (Guilding)
**Sinum maculatum* (Say)
Glyphepithema floridana Rehder
CASSIDIDAE
Cassis flammea Linné
**Morum oniscus* (Linné)
**Phalium granulatum* (Born)
**Cypraecassis testiculus* (Linné)
CYMATIIDAE
Charonia variegata (Lamarck)
Cymatium caribbaeum Clench & Turner
Cymatium labiosum (Wood)
**Cymatium femorale* (Linné)
**Cymatium muricinum* (Röding)
**Cymatium pileare* (Linné)
Cymatium nicobaricum (Röding)
Cymatium vespaceum (Lamarck)
BURSIDAE
Bursa corrugata (Perry)
Bursa cubaniana (Orbigny)
TONNIDAE
Tonna maculosa Dillwyn
MURICIDAE
Murex woodringi Clench & Farfante
Murex rubidus F. C. Baker
Chicoreus florifer (Reeve)
**Muricopsis oxytatus* M. Smith
Muricopsis philippiana (Dall)
Risomurex schrammi (Crosse)
Risomurex muricoides (C. B. Adams)
Morula nodulosa (C. B. Adams)
Morula didyma (Schwengel)
Thais deltoidea (Lamarck)
MAGILIDAE
Coralliophila deformis (Lamarck)
Coralliophila abbreviata (Lamarck)
COLUMBELLIDAE
**Anachis (Parvanachis) obesa* (C. B. Adams)
Anachis (Suturoglypta) pretri (Duclos)
**Astyris lunata* (Say)
Columbella mercatoria (Linné)
Conella ovuloides (C. B. Adams)
Cosmioconcha nitens (C. B. Adams)
Nitidella nitida (Lamarck)
**Steironepion monilifera* (Sowerby)
Zafrona pulchella (Blainville)
PISANIIDAE
Engina turbinella Kiener
**Bailya intricata* (Dall)
"Caducifer" adelus (Schwengel)
Cantharus auritulus (Link)
Pisania pusio (Linné)
COLUBRARIIDAE
**Colubraria testacea* (Mörch)
**Colubraria lanceolata* (Menke)
MELONGENIDAE
**Melongena melongena* (Linné)
NASSARIIDAE
Nassarius vinisculus (Reeve)
FASCIOLARIIDAE
Fasciolaria tulipa (Linné)
Fusilatirus cayohuesonicus (Sowerby)
Latirus infundibulum (Gmelin)
Latirus carinifera (Lamarck)
**Leucozonia nassa* (Gmelin)
Leucozonia ocellata (Gmelin)
TURBINELLIDAE
Turbinella angulatus Lightfoot
**Vasum muricatum* (Born)
OLIVIDAE
Oliva caribaeensis Dall & Simpson
Olivella nivea Gmelin
Olivella chiriquiensis Olsson & McGinty
Miniolia myrmecoon (Dall)
MITRIDAE
Mitra barbadensis (Gmelin)
**Mitra nodulosa* (Gmelin)
Pusia albocincta (Dall)
Pusia bistrio (Reeve)

Volutidae
Voluta virescens Lightfoot
Marginellidae
Prunum carneum (Storer)
Volvarina avena (Valenciennes)
Gibberula bocasensis Olsson & McGinty
Gibberulina ovuliformis (Orbigny)
Conidae
Conus spurius spurius Linné
Conus regius Gmelin
Conus daucus Linné
Conus granulatus Linné
Conus largillierti Kiener
Conus pygmaea Reeve
**Conus mus* Hwass
Conus mindanus Hwass
Conus jaspidea Gmelin
Terebridae
**Terebra taurinum* (Lightfoot)
Terebra spei Brown & Pilsbry
Turridae
Polystira albida (Perry)
"Drillia" albinodata Reeve
"Drillia" albomaculata C. B. Adams
"Drillia" acestra Dall
Syntomodrillia lissotropis (Dall)
Crassispira auberti Lamy
Crassispira harfordiana (Reeve)
Crassispira chazaliei Dautzenberg
Nannodiella oxytata (Bush)
Brachycythara biconica (C. B. Adams)
Ithycythara psila (Bush)
"Mangelia" filosa Rehder
Thelecythara floridana Fargo
Acmaturris sp.
Daphnella lymnaeiformis (Kiener)

OPISTHOBRANCHIATA

Bullidae
Bulla occidentalis A. Adams
Retusidae
Volvulella recta (Mörch)
Volvulella sp.
Cylichna bidentata (Orbigny)
Cylichna krebsi (Mörch)
Acteocina candei (Orbigny)
Atyidae
Atys guildingi (Sowerby)
Atys riisiana (Mörch)
Pyramidellidae
Pyramidella candida Mörch
Triptychus niveus (Mörch)
Odostomia gemmulosa (C. B. Adams)
Odostomia terryi Olsson & McGinty
Odostomia (Spiroclimax) sp.
Turbonilla pupoides (Orbigny)
Turbonilla sp. A.
Turbonilla sp. B.
Cavolinidae
**Cavolina longirostris* LeSueur

SCAPHOPODA

Dentaliidae
**Dentalium sowerbyi* Guilding
Dentalium antillarum Orbigny
Dentalium texasianum Philippi
**Cadulus tetraschistus* Watson

BIVALVIA

PROTOBRANCHIA

Nuculanidae
**Nuculana acuta* (Say)
Nuculana Sp.
[1]*Adrana newcombi* (Angas)
Nuculidae
Nucula aegeenis Jeffreys

FILIBRANCHIA

Glycymeridae
Glycymeris pectinata (Gmelin)
Arcidae
**Arca zebra* Swainson
Arca imbricata Bruguiére
Anadara notabilis (Röding)
**Anadara chemnitzi* (Philippi)
Barbatia cancellaria (Lamarck)
**Barbatia candida* (Helbling)
Arcopsis adamsi Dall
Pinnidae
Pinna carnea Gmelin
Plicatulidae
**Plicatula gibbosa* (Lamarck)
Pectinidae
"Pecten" laurenti Gmelin
**"Pecten" muscosus* Wood
"Pecten" fuscopurpureus Conrad
"Pecten" antillarum Recluz
**Nodipecten nodosus* (Linné)
Chlamys sentis (Reeve)
Chlamys imbricata (Gmelin)
**Argopecten nucleus* (Born)
Ostreidae
**Ostrea frons* Linné
Mytilidae
**Modiolus americanus* (Leach)
Lithophaga antillarum (Orbigny)
Botula fusca (Gmelin)
Isognomonidae
**Isognomon alatus* (Gmelin)
Isognomon radiatus (Anton)
Spondylidae
**Spondylus americanus* Hermann
Limidae
Lima scabra Born
Lima tenera Sowerby
Anomiidae
**Pododesmus rudis* (Broderip)

[1] (*Adrana perprotracta* (Dall). See: van Regteren Altena, 1968. *Basteria* 32(1-3).

EULAMELLIBRANCHIA

CRASSATELLIDAE
Crassinella adamsi Olsson

CONDYLOCARDIIDAE
**Condylocardia bernardi* Dall

LUCINIDAE
Lucina pensylvanica (Linné)
Lucina nassula Conrad
Lucina pectinatus (Gmelin)
**Lucina muricatus* (Spengler)
**Codakia orbicularis* (Linné)
**Codakia orbiculata* (Montfort)
**Codakia pectinella* (C. B. Adams)

CHAMIDAE
Chama congregata Conrad
Chama macerophylla Gmelin

CARDIIDAE
Laevicardium mortoni (Conrad)
**Laevicardium laevigatum* (Linné)
Laevicardium multilineata Dall & Simpson
**Trachycardium isocardia* (Linné)
**Trachycardium muricatum* (Linné)
Trigoniocardia antillarum (Orbigny)
**Americardia media* (Linné)
Papyridea soleniformis (Bruguière)

VENERIDAE
Chione cancellata (Linné)
**Chione paphia* (Linné)
**Macrocallista maculata* (Linné)
Callocardia albida (Gmelin)
**Antigona listeri* (Gray)
**Gouldia cerina* (C. B. Adams)
**Dosinia discus* (Reeve)

PETRICOLIDAE
**Rupellaria typica* (Jonas)

TELLINIDAE
**Tellina listeri* Röding
**Tellina punicea* Born
**Tellina angulosa* Gmelin
**Tellina martinicensis* (Orbigny)
Scissula exilis (Lamarck)
Macoma tenta (Say)
Arcopagia fausta (Pulteney)

SANGUINOLARIIDAE
Asaphis deflorata (Linné)

SOLENIDAE
Solecurtus cumingianus (Dunker)

MYIDAE
Sphenia antillensis Dall & Simpson

SEMELIDAE
**Semele purpurascens* (Gmelin)
**Semele proficua* (Pulteney)
Abra lioica Dall

CORBULIDAE
Corbula swiftiana C. B. Adams
Corbula dietziana C. B. Adams
Corbula cubaniana Orbigny
Corbula caribaea Orbigny
Notocorbula operculata (Philippi)

MONTACUTIDAE
Montacuta percompressa Dall

SEPTIBRANCHIA

CUSPIDARIIDAE
Cardiomya costellata (Deshayes)
Cardiomya perrostrata (Dall)

DISCUSSION

The geological history of southern Central America and northern South America is not completely understood. There is good evidence, however, that several major trans-American seaways existed in this area between the Middle Cretaceous and late Pliocene (Simpson, 1950: 363). The Atrato Strait (also known as the Bolivar Trough), in northwestern Colombia, was probably the widest and most enduring of these (Woodring, 1966); it may have been the last major channel (Whitmore and Stewart, 1965: 185). The time of closure of this strait, and concomitantly the completion of the land bridge, is somewhat in dispute. Woodring (*in litt.*) indicates that it could not have occurred before Pleistocene. Some paleontologists, however, have suggested an earlier, Miocene time of closure (Olsson, 1932: 39, 42; Durham and Allison, 1960: 67). Based on mammal evidence, most vertebrate paleontologists accept a late Pliocene date for this event (Whitmore and Stewart, 1965: 185).

A comparison of the Payardi Island fauna with the most complete listings of Panamic-Pacific species (Keen, 1958; Olsson, 1961) shows that at least 85 of the 297 Payardi Island species (29%) either occur in both the Caribbean and the eastern Pacific or are represented in the eastern Pacific by species here considered cognates[2] (Table 1).

[2]Closely related and allopatric species have often been termed analogues, particularly in malacological literature. However, because the term "analogy" has a widespread use in biology and implies similarity due to convergence, not relationship, the term "analogous" for closely related species is a potential source of confusion. Webster's New World Dictionary defines "cognate" as "related through the same origin; derived from a common original form." As this meaning is essentially the same as that of the malacologist's "analogue", I recommend that the latter term be dropped in favor of "cognate".

Many of the species considered as cognates in the present compilation have been previously suggested by Keen (1958) and/or Olsson (1961). Other cognates were determined by comparing morphological features of Pacific and Caribbean species; in some cases, figures in Olsson and Keen were utilized in the absence of specimens. In addition, some eastern Pacific cognates have almost certainly been overlooked, especially in families such as the Turridae and Pyramidellidae. Thus, the proportion of Payardi Island species with eastern Pacific cognates is probably greater than the 29% indicated. This percentage may be moderate to high if the idea of a Miocene or early Pliocene closure of the Atrato Strait is accepted, or as quite low in terms of a late Pliocene or early Pleistocene closure. Regardless of which view is taken, no zoogeographic or evolutionary conclusions can be drawn from this percentage of cognates.

No similar comparison may be made between the only other southwestern Caribbean fauna studied (Olsson and McGinty, 1958) and compilations of the Panamic-Pacific faunas (Keen, 1958; Olsson, 1961). Olsson and McGinty's paper deals solely with shallow-water mollusks collected from a variety of habitats in a relatively broad geographical area, on several occasions spanning more than thirty years. The present list, in contrast, includes only species collected from a relatively restricted area by an inherently more selective method. Thus, it is hardly surprising that these two Caribbean lists, although dealing with faunas within 200 miles of each other, show many dissimilarities.

Table 1

Closely Related Recent Species Occurring at Payardi Island and in Tropical East Pacific Faunas

Payardi Is. Species	Eastern Pacific Cognate
Hemitoma octoradiata (Gmelin)	*H. hermosa* (Lowe)
Diodora cayenensis (Lamarck)	*D. inequalis* (Sowerby)
Anticlimax schumoi (Vanatta)	*A. willetti* Hertlein & Strong
Astraea caelata (Gmelin)	*A. turbanica* (Dall)
Turbo castanea Gmelin	*T. squamiger* Reeve
Neritina virginea Linné	*N. luteofasciata* Miller
Alvania auberiana (Orbigny)	*A. inconspicua* (C. B. Adams)
Caecum pulchellum Stimpson	*C. diminuta* (C. B. Adams)
Rissoina fischeri Desjardin	*R. effusa* Mörch
Architectonica nobilis Röding	*A. nobilis* Röding
Heliacus perrieri (Rochebrune)	*H. infundibuliformis* (Gmelin)
Stephopoma myrakeenae Olsson & McGinty	*S. pennatum* Mörch
Modulus modulus Linné	*M. disculus* Philippi
Modulus carchedonius Lamarck	*M. catenulatus* Philippi
Cerithium variabile C. B. Adams	*C. nicaraguense* Pilsbry & Lowe
Cerithium litteratum Born	*C. maculosum* Kiener
Litiopa melanostoma Rang	*L. melanostoma* Rang
Crucibulum auricula (Gmelin)	*C. personatum* Keen
Xenophora conchyliophora (Born)	*X. robusta* Verrill
Strombus pugilis Linné	*S. gracilior* Sowerby
Cypraea zebra Linné	*C. cervinetta* Kiener
Cyphoma gibbosa (Linné)	*C. emarginata* (Sowerby)
Natica canrena (Linné)	*N. grayi* Philippi
Polinices lacteus (Guilding)	*P. uber* Valenciennes
Sinum maculatum (Say)	*S. debile* Gould
Phalium granulatum (Born)	*P. centriquadrata* Valenciennes
Morum oniscus (Linné)	*M. tuberculosum* Reeve
Cypraecassis testiculus (Linné)	*C. tenuis* Wood

TABLE 1 (cont.)

PAYARDI IS. SPECIES	EASTERN PACIFIC COGNATE
Cymatium femorale (Linné)	*C. tigrinum* (Broderip)
Cymatium pileare (Linné)	*C. pileare* (Linné)
[3]*Cymatium muricinum* (Röding)	[3]*C. muricinum* (Röding)
Muricopsis oxytatus M. Smith	*M. armatus* (A. Adams)
Astyris lunata (Say)	*A. barfordi* Strong & Hertlein
Anachis obesa (C. B. Adams)	*A. diminuta* (C. B. Adams)
Steironepion monilifera (Sowerby)	*S. melanosticta* Pilsbry & Lowe
Bailya intricata (Dall)	*B. anomala* (Hinds)
Colubraria testacea (Mörch)	*C. lucasensis* Strong & Hertlein
Colubraria lanceolata (Menke)	*C. siphonata* (Reeve)
Melongena melongena (Linné)	*M. patula* (Broderip & Sowerby)
Leucozonia nassa (Gmelin)	*L. rudis* (Reeve)
Vasum muricatum (Born)	*V. caestus* Broderip
Mitra nodulosa Gmelin	*M. marshalli* Bartsch
Terebra taurinum (Lightfoot)	*T. ornata* Gray
Conus mus Hwass	*C. mus* Hwass
Cavolina longirostris LeSueur	*C. longirostris* LeSueur
Dentalium sowerbyi Guilding	*D. innumerabile* Pilsbry & Sharp
Cadulus tetraschistus Watson	*C. quadrifissatus* (Carpenter)
Nuculana acuta (Say)	*N. hindsii* (Hanley)
Arca zebra Swainson	*A. pacifica* (Sowerby)
Anadara chemnitzi (Philippi)	*A. nux* (Sowerby)
Arcopsis adamsi Dall	*A. solida* (Sowerby)
Barbatia candida (Helbling)	*B. reeveana* (Orbigny)
Plicatula gibbosa Lamarck	*P. spondylopsis* Rochebrune
"Pecten" muscosus Wood	*"P." velero* Hertlein
Nodipecten nodosus (Linné)	*N. subnodosus* (Sowerby)
Argopecten nucleus (Born)	*A. circularis* (Sowerby)
Ostrea frons Linné	*O. serra* Dall
Isognomon alatus (Gmelin)	*I. chemnitzianus* (Orbigny)
Spondylus americanus Hermann	*S. princeps* Sowerby
Modiolus americanus (Leach)	*M. americanus* (Leach)
Pododesmus rudis (Broderip)	*P. cepio* (Gray)
Crassinella adamsi Olsson	*C. adamsi* Olsson
Condylocardia bernardi Dall	*C. panamensis* Olsson
Lucina muricatus Spengler	*L. liana* Pilsbry
Codakia pectinella (C. B. Adams)	*C. cancellaris* Philippi
Codakia orbicularis (Linné)	*C. pinchoti* Pilsbry & Lowe
Codakia orbiculata (Montfort)	*C. galapagana* Dall
Trachycardium isocardia (Linné)	*T. consors* (Sowerby)
Trachycardium muricatum (Linné)	*T. senticosum* (Sowerby)
Americardia media (Linné)	*A. guanacastensis* (Hertein & Strong)
Laevicardium laevigatum (Linné)	*L. clarionense* (Hertlein & Strong)
Papyridea soleniformis (Bruguiére)	*P. aspersa* (Sowerby)
Dosinia discus (Reeve)	*D. ponderosa* (Gray)
Chione paphia (Linné)	*C. mariae* (Orbigny)
Macrocallista maculata (Linné)	*M. squalida* (Sowerby)
Antigona listeri (Gray)	*A. multicostata* (Sowerby)
Gouldia cerina (C. B. Adams)	*G californica* Dall
Rupellaria typica (Jonas)	*R. robusta* (Sowerby)
Tellina listeri Röding	*T. cumingi* (Hanley)
Tellina punicea Born	*T. simulans* C. B. Adams
Tellina angulosa Gmelin	*T. eburna* Hanley
Tellina martinicensis Orbigny	*T. proclivis* Hertlein & Strong
Semele purpurascens (Gmelin)	*S. sparsilineata* Dall
Semele proficua (Pulteney)	*S. lenticulare* (Sowerby)

[3]*Cymatium muricinum* (Röding) has been collected in the Galápagos (Emerson, pers. comm.)

Acknowledgments

In addition to my obvious debt to Messrs. Stewart and Meña, I wish especially to thank Dr. Joseph Rosewater, Division of Mollusks, U. S. National Museum, for providing facilities to study this fauna. Most of the present research was undertaken while I was a Smithsonian Predoctoral Intern. Dr. Donald R. Moore, Institute of Marine Sciences, University of Miami, kindly assisted in identifying the caecids, vitrinellids, cyclostremids, and other difficult groups.

Thanks are also due the following individuals for reading preliminary drafts of this paper and providing constructive citicism: Drs. Joseph Rosewater, Harald A. Rehder, and Wendell P. Woodring, U. S. National Museum; Dr. William K. Emerson, American Museum of Natural History; Dr. Reid Moran, Messrs. Arnold Ross and Allan J. Sloan and Mrs. Fay H. Wolfson, San Diego Natural History Museum.

Figure 1 was prepared by Miss Gail Culver and Miss Anne Acevedo, San Diego Natural History Museum.

Literature Cited

Durham, J. W. and E. C. Allison
1960. The geologic history of Baja California and its marine faunas. Syst. Zool. 9: 47-91.

Keen, A. M.
1958. Sea Shells of Tropical West America. Stanford University Press, 624 p.

Olsson, A. A.
1932. Contributions to the Tertiary paleontology of northern Peru. Pt. 5, The Peruvian Miocene. Bull. Amer. Paleontol. 9: 1-272.
1961. Mollusks of the Tropical Eastern Pacific; Panamic-Pacific Pelecypoda. Paleont. Res. Inst., Ithaca, New York, 574 p.

Olsson, A. A. and T. L. McGinty
1958. Recent marine mollusks from the Caribbean coast of Panama with description of some new genera and species. Bull. Amer. Paleontol. 39: 5-58.

Simpson, G. G.
1950. History of the fauna of Latin America. American Scientist 38: 361-389.

Whitmore, F. C., Jr. and R. H. Stewart
1965. Miocene Mammals and Central American Seaways. Science, 148: 180-185.

Woodring, W. P.
1966. The Panama land bridge as a sea barrier. Proc. Amer. Philos. Soc. 110: 425-433.

Accepted for Publication 10 May 1969

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STUDIES ON THE TETRACLITIDAE (CIRRIPEDIA: THORACICA): REVISION OF *TETRACLITA*

ARNOLD ROSS

TRANSACTIONS

OF THE SAN DIEGO
SOCIETY OF
NATURAL HISTORY

VOL. 15, NO. 15 22 SEPTEMBER 1969

STUDIES ON THE TETRACLITIDAE (CIRRIPEDIA: THORACICA): REVISION OF *TETRACLITA*

ARNOLD ROSS

ABSTRACT. — *Tesseropora* and *Tetraclitella*, subgenera of *Tetraclita*, are elevated to full generic status in the absence of intergrading major characters. **Newmanella** gen. nov. is proposed for *Tetraclita (Tetraclita) radiata* (Bruguiere, 1789) and **Tesseroplax** gen. nov. for *Tetraclita (Tesseropora) unisemita* Zullo, 1968. On the basis of shell characters the five genera here recognized fall into two groups. Monometric growth, allometry of the carina, and non-tubiferous radii characterize *Tesseropora*, *Tesseroplax*, and *Tetraclita*; diametric growth, isometry of the wall plates, and tubiferous radii characterize *Tetraclitella* and *Newmanella*. Both *Tesseroplax* and *Tetraclita* are considered later derivatives from the *Tesseropora* stock; but *Tetraclitella* and *Newmanella* from a tesseroporan precursor. New distributional records for *Newmanella radiata* include the Bahamas, Puerto Rico, Dominica, and Venezuela. Apparently the antenniform ramus of cirrus III in *N. radiata* plays some role during the reproductive cycle, but its exact function is unknown.

RESUMEN. — *Tesseropora y Tetraclitella*, subgénero de *Tetraclita*, estan elevados al estado genérico en la ausencia de intergradación carácteres mayores. **Newmanella** gen. nov. esta propuesto para *Tetraclita (Tetraclita) radiata* (Bruguière, 1789) y **Tesseroplax** gen. nov. para *Tetraclita (Tesseropora) unisemita* Zullo 1968. En el base de carácteres de concha los cinco géneros reconocidos aquí, caen en dos grupos. Crecimiento monométrico, alometría de la carena, y radios no-tubiferoso caracterizan *Tesseropora*, *Tesseroplax*, y *Tetraclita;* crecimiento diamétrico, isometría de la láminas de las paredes, y radios tubiferoso caracterizan *Tetraclitella* y *Newmanella*. Los dos *Tesseroplax* y *Tetraclita* son considerados derivativos mas tarde de los progenitores de *Tesseropora*, pero *Tetraclitella* y *Newmanella* de un progenitor de *Tesseropora*. Registros distribucionales nuevos por *Newmanella radiata* se incluyen las Bahamas, Puerto Rico, Dominica, y Venezuela. Aparentemente, la ramal antenniforma de cirrus III en *N. radiata* hace un papel durante los reproductivos, pero su función exacto es desconocido.

The Tetraclitidae comprise a group of intertidal balanomorph barnacles occurring in tropical and warm-temperature waters between latitudes 38° north and 52° south. Although these barnacles are a major component of intertidal faunas they have not received adequate attention either taxonomically or biologically. In this, the first in a series of papers covering the taxonomy and general biology of the tetraclitids, I re-evaluate the status of *Tetraclita* and its subgenera, and propose a new classification in the light of recent studies (Ross, 1968), and the work of Darwin (1854), Nilsson-Cantell (1921) and Hiro (1939).

There are more than two dozen named taxa distributed presently between *Tetraclita* Schumacher, 1817 (type species: *T. (Tetraclita) squamosa* (Bruguiere), 1789), and its subgenera, *Tesseropora* Pilsbry, 1916 (type species: *T. (Tesseropora) rosea* (Krauss), 1848), and *Tetraclitella* Hiro, 1939 (type species: *T. (Tetraclitella) purpurascens* (Wood), 1815). These subgenera are distinct, and their elevation to generic status clarifies relationships that are obscured when all of the species are considered monogeneric.

Both Darwin (1854: 344) and Hiro (1939: 270) cited numerous morphological characters that support the generic distinctness of the Caribbean western Atlantic species, *T. radiata*. These characters, coupled with the absence of intergrading major morphological structures, necessitate the proposal of *Newmanella* gen. nov. for this species. Attempts to assign the recently described Pliocene species from the Gulf of California, Mexico, *T. (Tesseropora) unisemita* (Zullo, 1968: 273), within the proposed classification posed innumerable problems, and consequently I have placed it in a new genus, *Tesseroplax*.

FAMILY TETRACLITIDAE Gruvel

Tétraclitinés Gruvel, 1903: 160; Nilsson-Cantell, 1921: 357, nom. transl.; Ross, 1968: 6, nom. transl.

Definition. — Balanomorpha with shell of 4 plates; rostrum compound; compartments demarcated along sutures on interior surface of wall when fused or corroded externally; parietes with one or more rows of separate or confluent tubes containing living tissue or secondarily filled with calcareous and chitinous material; overlapping plates with radii. Basis membranous or calcareous and not forming complex interdigitations with wall. Inferior margin of mandible pectinate or serrate, never molariform. Labrum not bullate; crest with or without shallow notch, never incised. Cirrus II and III commonly armed with bipinnate and other complex setae distributed along anterior curvature; cirrus III resembling II more than IV; inner or outer ramus commonly antenniform during reproductive cycle. Basidorsal point on intromittent organ, and caudal appendages absent. Occurring in intertidal zone, generally on inanimate objects. Type genus: *Tetraclita* Schumacher, 1817.

Remarks. — Authorship of this family must be accorded Gruvel (1903: 160) rather than Nilsson-Cantell (1921: 357) as earlier noted (Ross, 1968: 6), and the date of authorship accepted as 1903, because "A family group name of which the suffix is incorrect is available with its original date and authorship, but in properly emended form" (Article 11 (e) (ii), ICZN).

INTRAFAMILIAL RELATIONSHIPS

In the Tetraclitidae shell growth proceeds either diametrically or monometrically (Darwin, 1854: 324). In monometric growth there is a direct correlation between obsolescence of the radii, which are nontubiferous, secondary apical filling of the parietal tubes, and enlargement of the orifice by attrition or corrosion. In diametric growth enlargement of the orifice results directly from growth of the tubiferous radii normal to the parietes without wearing away the peritreme, and the parietal tubes are not secondarily filled.

These modes of shell growth allow separation of the tetraclitids into two groups (Fig. 1). Monometric growth characterizes *Tesseropora, Tesseroplax* and *Tetraclita,* diametric growth *Tetraclitella* and *Newmanella.* The latter method is the phylogenetically more primitive based upon the fossil record.

Equally important in segregating the tesseroporan line from the tetraclitellan is the allometry of the carina that occurs commonly in the former group but not the latter. In the tetraclitellans all of the plates develop essentially isometrically. Allometry of the carina and adjacent laterals is a somewhat recent departure from the isometry characteristic of early balanomorphans and is always directly associated with monometric shell growth. Conversely, isometry of the wall plates occurs concomitantly with diametric growth.

Enlargement of the orifice in the tesseroporans, which have monometric shell growth, results from attrition or corrosion of the peritreme, and this is facilitated by their occupancy of a poorly protected high intertidal habitat. In the tetraclitellans enlargement of the orifice is by diametric growth, and this group occurs in relatively well protected habitats low in the intertidal zone. In both groups, the parallel development of a multilayered wall probably confers a selective advantage in that it provides protection against rapacious gastropods and other boring predators.

Tetraclita was probably derived from *Tesseropora,* which retains a single row of parietal tubes. Henry (1957: 36) showed that secondary longitudinal tubules in some individuals of *Tesseropora pacifica* (Pilsbry) is "the first step in the formation of a multilayer wall." She assigned this species to *Tetraclita (sensu stricto)* because of the presence of

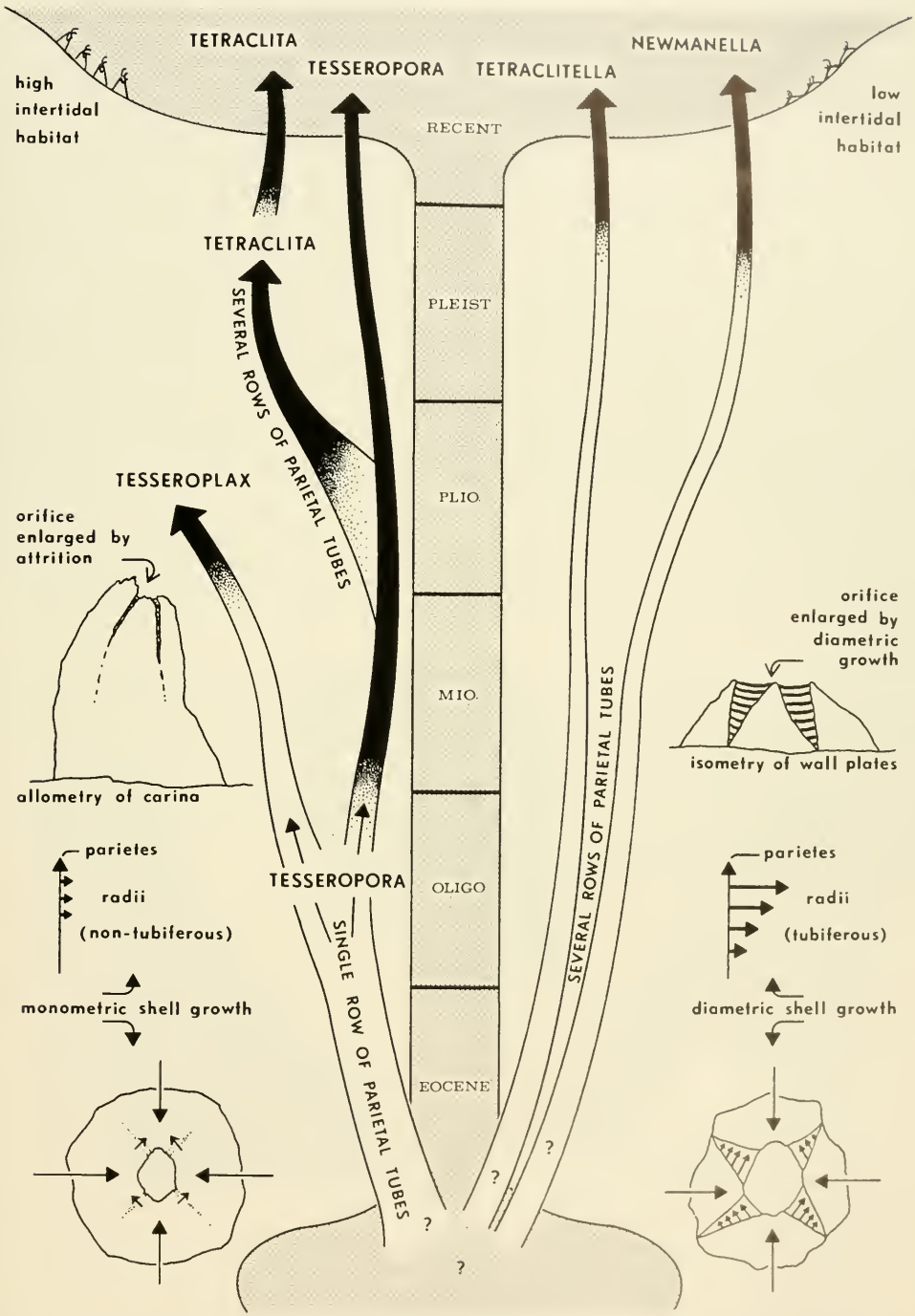

Figure 1. Inferred phylogeny and generic affinities in the Tetraclitidae. Peripheral illustrations portray aspects of shell growth and morphology, and key characters used in distinguishing the two groups in this family.

secondary tubules. However, this assignment is contrary to the original definition of the genus; the secondary tubules are not comparable to those of *Tetraclita*, because there is but one complete row in this species and in certain crowded specimens of *T. rosea* (see Zullo, 1968: 272).

Tesseroplax also has but one row of parietal tubes, and therefore is more closely related to *Tesseropora* than to *Tetraclita*. I regard the absence of depressor muscle crests on the scutum and removal of the tergal spur from the basiscutal angle to be primitive characters in *Tesseroplax* as well as in *Tetraclitella*. The septate parietal tubes in *Tesseroplax* represent a unique specialization for this family, and their function remains unknown, although they may strengthen the wall. *Tesseroplax* probably represents an early off-shoot from the tesseroporan line, as Zullo (1968: 274) suggested, and it is evidently an evolutionary terminus, since none of the presently recognized species can be shown to have evolved from *T. unisemita*. The morphological evidence in support of Zullo's alternate hypothesis that *T. unisemita* may be the result of "convergence on the tetraclitan shell plan from an unrelated ancestor," is weak. The narrow opercular plates in *Tesseroplax*, especially the tergum, may be a direct consequence of monometric growth and allometry in this and other tesseroporans. These attributes strengthen the inference that *Tesseroplax* is in the direct line of descent from *Tesseropora*.

Tetraclitella and *Newmanella* appear to have been derived independently from a tesseroporan precursor, the shell of which had a single row of parietal tubes and developed diametrically. The presence in these genera of two or more rows of parietal tubes, as in *Tetraclita*, I consider a later development which may function as defense against boring predators.

Since each of these tetraclitellans possesses several primitive morphological characters, it is not possible to deduce which genus is more primitive phylogenetically. The scutum in *Tetraclitella*, although elongated, is still basically triangular, and it lacks crests for the insertion of the lateral and rostral depressor muscles. The same is true in *Tesseroplax*. The wall plates in *Tetraclitella* are weakly articulated and do not develop the complex occlusial surface found in *Newmanella*. On the other hand, the tubes in the radii of *Tetraclitella*, to judge from other balanomorphs (e.g., *Megabalanus, Emersonius, Platylepas*) reflect a highly advanced and complex mode of formation.

KEY TO GENERA OF TETRACLITIDAE

1. Growth of shell monometric; radii solid 2
1. Growth of shell diametric; radii tubiferous 4
2. Parietes with one row of tubes 3
2. Parietes with two or more rows of tubes ..... *Tetraclita*
3. Parietal tubes lacking transverse septa; scutum bearing depressor muscle crests ..... *Tesseropora*
3. Parietal tubes bearing transverse septa; scutum lacking depressor muscle crests ..... *Tesseroplax* gen. nov.
4. Radii with horizontal summits, articular margins lacking teeth; scutum transversely elongated, lacking depressor muscle crests ..... *Tetraclitella*
4. Radii with oblique summits, articular margins bearing prominent teeth; scutum triangular, bearing depressor muscle crests ..... *Newmanella* gen. nov.

Tesseroplax gen. nov.

Definition. — Shell moderately large, smooth; compartments discrete; parietes with one row of rectangular tubes secondarily filled apically, septate basally; radii narrow, non-tubiferous; basis calcareous, with transverse septate tubes; scutum triangular, lacking crests for depressor muscles; tergum narrow, with spur separated from basi-scutal angle.

Type species. — *Tetraclita (Tesseropora) unisemita* Zullo, 1968.

Etymology. — Derived from the Greek, *tesseres,* four, and *plax,* plate, in reference to the number of parietal plates.

Remarks. — *Tesseroplax unisemita* is known only from two specimens collected from Pliocene sediments on Angel de la Guarda Island in the Gulf of California, Mexico. Many supposedly unique characters were attributed to this extinct species; but the absence of depressor muscle crests on the scutum is typical of *Tetraclitella;* internal parietal ribs also occur in *Newmanella;* and the apical filling of the parietal tubes is a characteristic of *Tetraclita* as well as *Tesseropora.* However, *Tesseroplax* is the only tesseroporan possessing septate parietal tubes and a calcareous basis also with septate tubes. These structures as well as internal parietal ribs probably reflect a unique method of shell deposition in this lineage. *Tesseroplax* is also the only tesseroporan in which the scutum lacks depressor muscle crests, and the spur of the tergum is infolded as well as being extremely narrow and elongate.

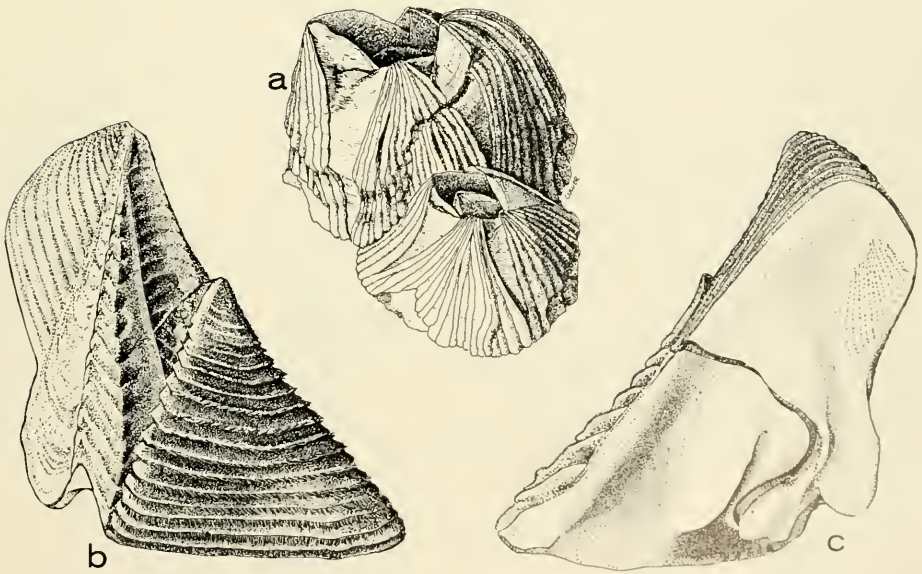

Figure 2. *Newmanella radiata,* from test panel set at 15 m, Vieques Sound, Puerto Rico. a, contiguous specimens viewed from left side, actual height of upper specimen 23.1 mm; b, c, external and internal views, respectively, of articulated opercular plates, actual height of scutum 13.9 mm, tergum 9.5 mm.

Newmanella gen. nov.

Definition. — Shell relatively large, conic, ribbed; compartments discrete; parietes with 2 or more rows of irregularly shaped tubes; radii broad, summits oblique, tubes opening on articular surface; basis calcareous, solid, scutum triangular, bearing crests for depressor muscles; tergum narrow with spur separated from basiscutal angle; mandible with 4 teeth, basal comb, and spine-like lower extremity; maxilla I with more than 12 spines below subapical notch.

Type species. — *Balanus radiata* Bruguière, 1789.

Etymology. — Named in honor of Dr. William A. Newman, Scripps Institution of Oceanography, longtime friend, and student of the Cirripedia.

Remarks. — The presence of more than one row of parietal tubes and well developed tubiferous radii serve to distinguish *Newmanella* from the tesseroporan complex. The radial tubes in *Newmanella* differ from those of *Tetraclitella* by being irregular in outline and of varying size and by their mode of formation, which results from development of prominent irregular ridges on the sutural surface that branch and coalesce. The radial tubes in *Tetraclitella* are uniform in size and outline and develop in a manner comparable to that of the parietal tubes. Initially growth is normal to that of the parietes, but with subsequent growth and sequential development of additional tubes along the outer lamina of the radius, the earlier formed radial tubes curve and may extend downward to the base.

Newmanella radiata (Bruguière)

[Lepas Indiae orientalis ex violaceo radiata] Chemnitz, *in* Martini and Chemnitz, 1785: 319, pl. 99, fig. 842.
Balanus radiata Bruguière, 1789: 168; Bruguière, 1791, pl. 164, figs. 5, 5a.
Lepas purpurea Spengler, 1790: 172.
Lepas violacea Gmelin, 1791: 3213, not *Balanus violaceus* Gruvel, 1903 [= *Balanus abeli* Lamy and Andre, 1932: 218, footnote].
Balanus radiatus: Ranzani, 1818: 75; Lamarck, 1818: 393; Ranzani, 1820: 39; Jay, 1839: 7; Lamy and Andre, 1932: 218.
Conia radiata: Blainville, 1824: 378; Blainville, 1825: 598; Blainville, 1827, pl. 85, figs. 5, 5a; Deshayes, 1831: 357.
T[etraclita](C[onia])radiata: Gray, 1825: 104.
Conia lyonsii (ex Leach, *MS)* Sowerby, 1823, no pagination.
Tetraclita radiata: Darwin, 1854: 343, pl. 11, figs. 5a-5d; Weltner, 1897: 258; Gruvel, 1903: 161; Gruvel, 1905: 291; Schmalz, 1906: 65, pl. 6, fig. 4; Hoek, 1907: xvi; Pilsbry, 1916: 259, pl. 61, figs. 3-3c, 4; Pilsbry, 1927: 38; Nilsson-Cantell, 1939: 5; Pope, 1943: 244; Pope, 1945: 368; Pilsbry, 1953: 27; Southward, 1962: 163; Ross, 1968: 18.

Material. — Turtle Rocks, south of Bimini, Bahamas, B.W.I., approximately 25°40′N., 79°20′W.; intertidal on exposed hull of wrecked ship; E. Kirsteuer coll., August 1967; 5 specimens.

Vieques Sound, Puerto Rico, approximately 18°12′N., 65°25′W.; on fouling test panel set at 15m below surface; U.S. Naval Oceanographic Office, October 1966; 4 specimens.

Vieques Island, Puerto Rico; intertidal; J. A. Rivera and C. B. Rivera coll., November 17, 1951; 10 specimens.

Scotts Head Bay, Dominica, approximately 15°21′40″N., 61°22′40″W.; intertidal on *Tetraclita stalactifera* (Lamarck); E. Kirsteuer and K. Rützler coll., May 17-28, 1966; 1 specimen.

Isla de Margarita, Venezuela, approximately 10°45′N., 64°52′W.; intertidal; P. Glynn coll., May 28, 1968; 7 specimens.

Gulf of Paria, Trinidad, approximately 10°12′N., 61°52′W.; on marine structures in the Shell Trinidad Ltd. oilfield; R. Bacon coll., May 30, 1968; 10 specimens.

Supplementary Description. — Shell white; low-conic; ribs on parietes numerous,

approximate, narrow, prominent, generally branched basally (Fig. 2a). Orifice large, trigonal to pentagonal; peritreme slightly toothed. Radii broad; horizontally striated; summits oblique, at 45° or less; ridges on articular margin irregular, with interspaces forming tubes opening on margin. Alae with summits less oblique than radii; articular margin toothed horizontally. Wall of body cavity with regular longitudinal ribs. Parietes with more than 1 row of irregularly spaced large and small tubes, without definite pattern; longitudinal septa thick, crenated basally. Shell measurements are given in Table 3 of the Appendix.

Basis calcareous; translucent; thin centrally, thickening peripherally.

Scutum triangular; articular ridge high, effectively erect, evenly rounded terminally,

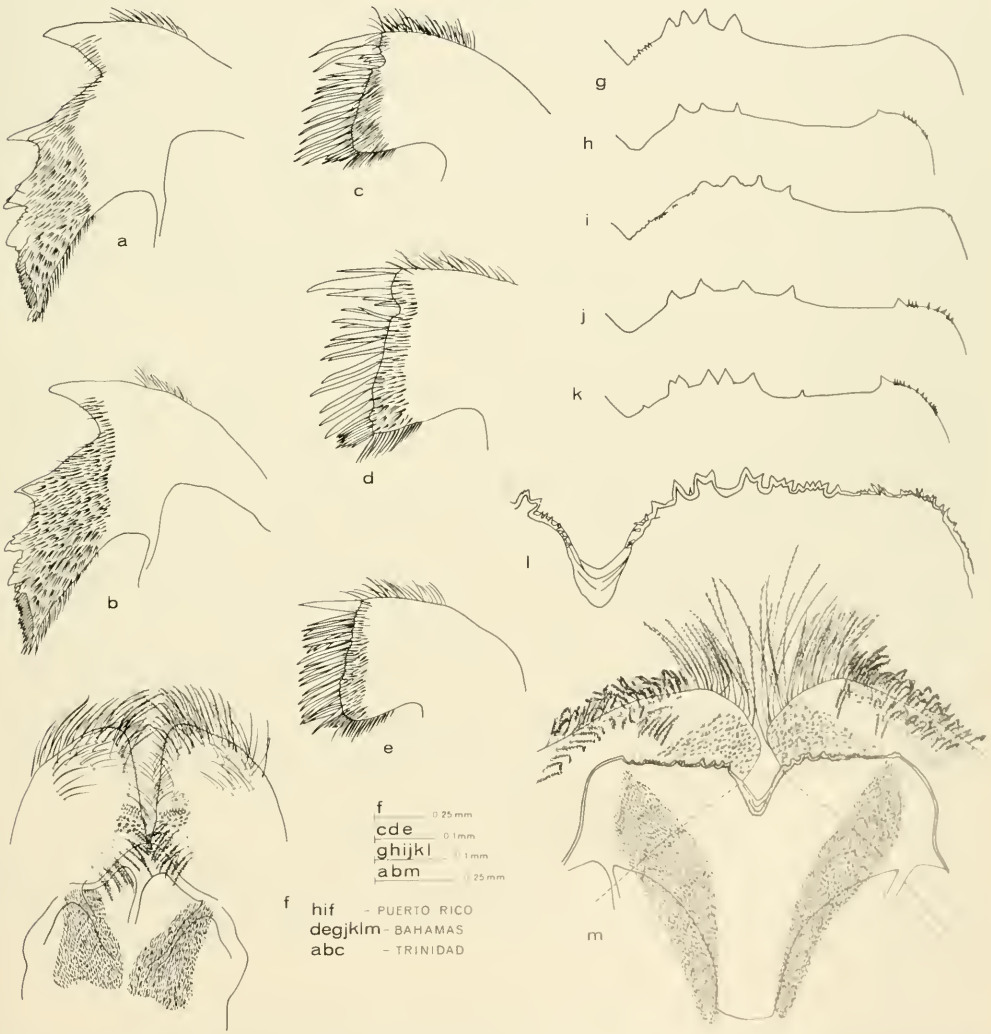

Figure 3. *Newmanella radiata*, trophi. a, b, mandible; c-e, maxilla I; f, maxilla II; g-k, crest of labrum; l, enlarged view of crest of labrum in m; m, labrum and palps.

about 2/3 length of margin; articular furrow extremely broad and deep; adductor muscle ridge thin, relatively short, apically confluent with articular ridge; adductor muscle depression shallow, poorly defined, crests for lateral and rostral depressor muscles few in number, low, short.

Tergum triangular; longitudinal furrow broad, shallow; spur fasciole open; spur obliquely rounded, separated from basiscutal angle by less than its own width; articular ridge high, projecting and covering apical 1/3 of scutum when articulated (Fig. 2c); articular furrow broad and deep; crests for depressor muscles numerous, low, regularly spaced.

Crest of labrum with broad V-shaped medial notch either smooth or laterally toothed; teeth on crest either simple, M-shaped or comb-like, numbering commonly 3-4, ranging 2-7 (Figs. 3g-l); superolateral margins of labrum finely serrate or toothed; interspersed among teeth, in notch, and extending laterally along crest of labrum are short, soft bristles. Palps elongate, rectangular; basal margins free of setae; superior margin clothed with short, broad, bipectinate setae; inner lateral face clothed completely with ctenae; distal extremity bearing long, slender, bipinnate setae. Cutting edge of mandible armed with 5 teeth including inferior angle; teeth 2-4 support subsidiary cusps; superior slope of tooth 4 serrate; inferior angle bears 3-4 acicular teeth; comb between tooth 4 and inferior angle contains 17-20 acicular teeth (Figs. 3a-b). Maxilla I with deep, U-shaped notch, rarely without notch; spination along cutting edge in three functional clusters; 2 long, stout spines above notch and 6-9 short, slender spines above or running into notch; 13-20 long, slender spines medially, grading into basal zone of 7-13 short, slender spines. Maxilla II bilobate, taller than broad; setae of apical lobe long, bipinnate, but shorter and bipectinate on lower lobe; region of juncture of two lobes covered with short, narrow spines and ctenae.

Posterior ramus of cirrus I about 2/3 or less length of anterior ramus; intermediate articles of both rami broader than high; segments of anterior ramus normal, posterior protuberant (Fig. 4a). Rami of cirrus II either essentially equal in length or posterior ramus antenniform (Fig. 4b); terminal segments of anterior ramus armed with few bipinnate setae; proximal and intermediate articles of both rami bullate when cirrus normal. Rami of cirrus III either equal in length or posterior ramus antenniform; when rami are equal, lesser curvature of anterior ramus not covered with spines, and setae are bipectinate; when rami are unequal in length lesser curvature of intermediate and basal segments of both rami covered with short triangular or hook-like spines, and setae bipectinate only on anterior ramus. Cirri IV-VI essentially equal in length with equal rami. Anterior face of posterior ramus of cirrus IV covered with short, triangular spines; proximal segments of both rami along posterior face also spinose. Proximal segments of cirri V-VI covered with short spines along greater curvature only. Chaetotaxis of intermediate articles of cirri IV-VI ctenopod along anterior curvature, with 4 pairs; between or at bases of apical pair are 1-2 short slender setae. Cirral counts are summarized in Table 1 of the Appendix.

Intromittent organ distinctly annulated throughout its length; sparsely hirsute except for 2 distinct clusters surrounding terminal orifice (Fig. 4e).

Remarks. — *Newmanella radiata* is apparently limited to the Caribbean, having been reported from Florida (Pilsbry, 1957: 27), St. Thomas, Virgin Islands (Pilsbry, 1916: 259), and Monos Island, Trinidad (Southward, 1962: 163). New records, which considerably fill gaps in this species distribution include the Bahamas, Puerto Rico, Dominica, and Venezuela.

FUNCTIONAL SIGNIFICANCE OF ANTENNIFORMY

In some individuals both rami of cirrus III are normal, but in others one is normal and one antenniform (setae arranged in whorls at each articulation and the segments articulated

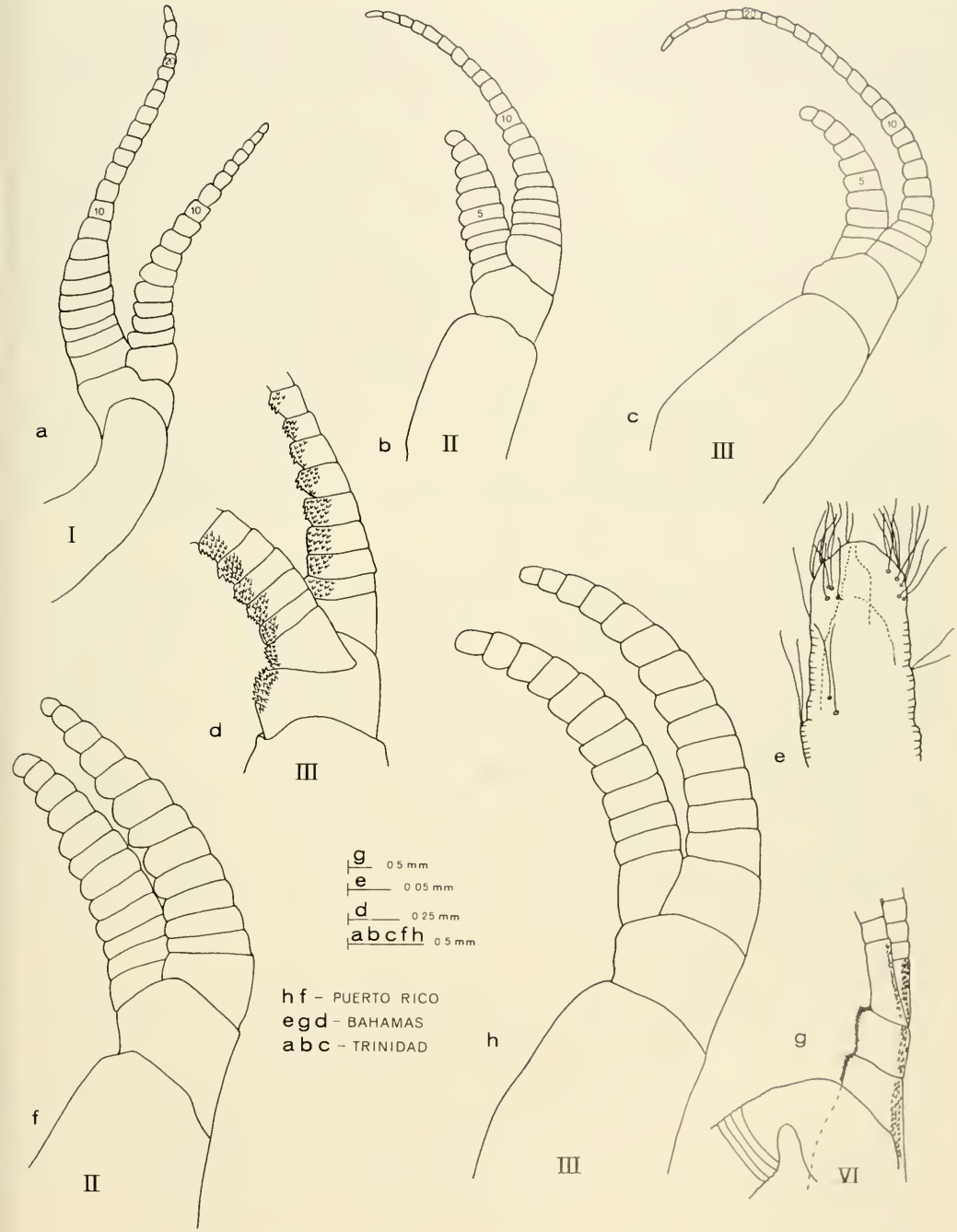

Figure 4. *Newmanella radiata*, cirral appendages. a, left cirrus I; b, left cirrus II with antenniform posterior ramus; c, left cirrus III with antenniform posterior ramus; d, proximal segments of right cirrus III; e, distal end of intromittent organ; f, normal left cirrus II; g, basal segments of left cirrus VI, pedicel, and proximal portion of intromittent organ; h, normal left cirrus III.

so that the ramus can be rotated through 360°). Antenniformy is apparently not widespread in the Chthamalidae, and is unknown in the Balanidae. Of the tetraclitid genera recognized herein only *Tetraclitella,* to my knowledge, does not exhibit antenniformy, and it is apparently rare in *Tesseropora.*

Darwin (1854: 83) noted variability in the occurrence of an antenniform ramus in chthamalids, and stated that the ramus "acts as an organ of touch." In the deep sea chthamalid *Hexelasma hirsutum* (Hoek), Southward and Southward (1958: 642) found the antenniform ramus to be less sensitive to touch than rami of the other cirri. They noted also that the antenniform rami do not form part of the food gathering cirral net, which would be precluded by the nature of its armament, and speculated that the rami might function as direction indicators, permitting alignment of the net with prevailing food-laden currents. This seems unlikely because individuals with antenniform rami also occur in intertidal habitats, where there is no obvious adaptive value for such an organ.

Pope (1965: 59) detected no correlation between the presence or absence of an antenniform ramus and age, seasonal or environmental variables. However, seventy per cent of the eastern Australian population of *Chthamalus antennatus* Darwin that she studied, had antenniform rami, and 80 per cent of the total population were brooding. Specimens collected three weeks later from the same area had normal rami, but only 20-35 per cent still contained developing nauplii. At no time did all individuals in the population have antenniform rami.

In *Newmanella,* the May specimens from Venezuela had antenniform rami and were brooding nauplii, but the opposite was true of specimens collected from Dominica and Trinidad, except for one individual from Trinidad that had antenniform rami. Specimens taken in August from the Bahamas and in October and November from two localities off Puerto Rico also lacked antenniform rami and eggs or nauplii in the mantle cavity (Fig. 5). Development of the antenniform ramus in *N. radiata* probably begins in February or March, and the appendage is shed in April or May only to be replaced by a normal ramus.

Specimens of *Tetrachthamalus oblitteratus* from Mauritius were found to have normal rami, and one individual was brooding; those from Elat, and all but one from Seychelles, had antenniform rami, and both populations were brooding eggs or nauplii (Newman, 1967: 430; pers. comm.). Newman also observed that individuals with antenniform rami either lack or have a diminutive intromittent organ, whereas individuals with normal rami have a normally developed intromittent organ. In *Tesseropora pacifica* from Guam I have observed the simultaneous presence of an antenniform ramus, reduced intromittent organ, and eggs in the mantle cavity.

According to Crisp and Patel (1958: 1078) copulation and fertilization commonly follow within a few days of ecdysis. However, ecdysis early in the reproductive cycle normally results in loss of the recently oviposited eggs, because they lie in the mantle cavity, the lining of which is molted with exuviae of the appendages, intromittent organ, prosoma, esophagus, and rectum (Darwin, 1854: 157). Consequently, newly fertilized individuals normally cease molting during the brooding period, which lasts for several weeks. But, if the molting process is resumed after fertilization but prior to naupliar release, the mantle lining is retained and complete exuviation either accompanies or follows liberation of the nauplii (Patel and Crisp, 1961: 103). In *Balanus balanoides* Linnaeus the intromittent organ is lost during exuviation after the time of fertilization, whether the individuals have been fertilized or not (Crisp and Patel, 1960: 33). A new one gradually develops during the summer, reaching a normal length prior to the onset of the breeding season, which in *B. balanoides* occurs annually in November or December; development of the intromittent organ in *Tetrachthamalus* and *Tesseropora pacifica* probably follows a similar pattern as does the

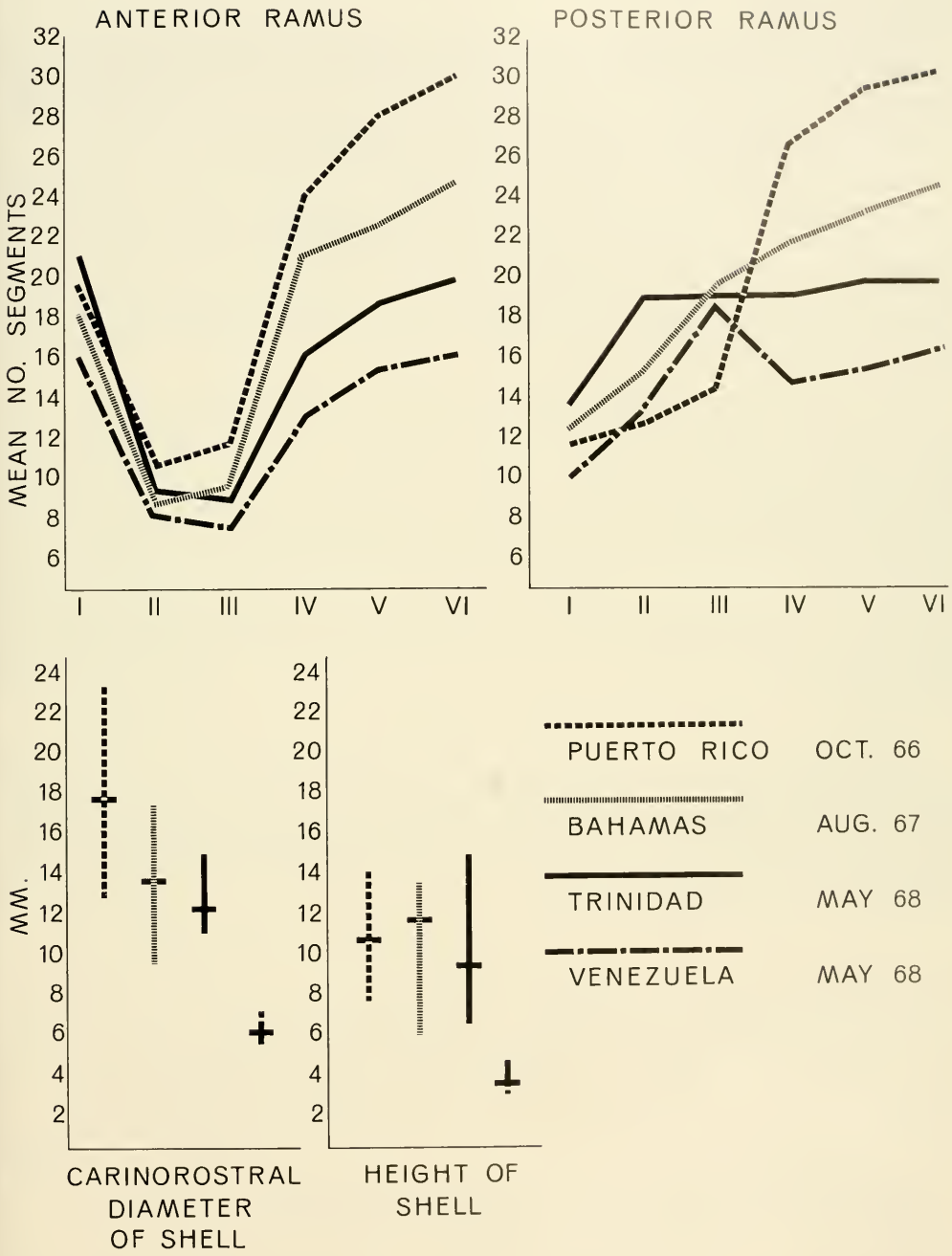

Figure 5. Graph of mean values from Table 1 for cirral counts of anterior ramus (top left) and posterior ramus (top right), and from Table 3 for carinorostral diameter of shell (bottom left) and height of shell (bottom right) of *Newmanella radiata*. Vertical line = range; horizontal bar = mean.

antenniform ramus.

Thus, there is a strong correlation between the reproductive period and the presence of antenniform rami. In all cases, antenniform rami are noted first either immediately before, during, or immediately after the reproductive period, which may occur more than once a year in the chthamalids and tetraclitids. The presence of an antenniform ramus has not been reported in individuals long after termination of the reproductive cycle.

In cross-fertilizing intertidal balanomorphs copulation takes place while the animals are submerged. Some means of indicating copulatory availability would be advantageous during this phase of the reproductive cycle, because these animals are monoecious and every individual in the population is potentially capable of being fertilized by another nearby individual. Since the periods of submergence are usually brief, some adaptation would be effective in insuring rapid selection of a responsive individual. The antenniform ramus may elicit or detect tactile or chemical stimuli from an individual acting the role of the opposite sex.

The correlation between brooding, antenniformy, and penis development is complicated. However, it appears that individuals brooding eggs or nauplii, having antenniform rami, and lacking or having diminutive penes assume the morphology and act the role of a female; those individuals without eggs or nauplii in mantle cavity, and with normal rami and penes constitute the post-reproductive segment of the population, having reverted to the normal hermaphroditic state. Resumption of the hermaphroditic state is necessary because these animals will cross-fertilize during the next breeding season. Loss or diminution of the intromittent organ after fertilization is not comparable to the loss of the antenniform ramus after release of the nauplii, because the ramus is replaced by a functional, feeding appendage, whereas the intromittent organ remains non-functional until the onset of the following breeding season.

ACKNOWLEDGMENTS

I am indebted to Dr. William A. Newman, Scripps Institution of Oceanography, for his continued encouragement, loan of specimens, and valuable comments on an earlier draft of the manuscript. I thank Ernst Kirsteuer, American Museum of Natural History, John R. DePalma, U.S. Naval Oceanographic Office, Elizabeth Pope, the Australian Museum, Huzio Utinomi, Seto Marine Biological Laboratory, and Peter Bacon, University of the West Indies, Trinidad, for their assistance in providing me with specimens. Miss Gail Culver prepared figures 1 and 2, and Miss Anne Acevedo figures 3 through 5.

LITERATURE CITED

Blainville, H. M. de
1824. Nematopoda. Dict. Sci. Nat. 32 (Mollusques – Morfil). Strasbourg, F. G. Levrault. 567 p.
1825-1827. Manual de malacologie et de conchyliologie. Paris, F. G. Levrault. 664 p. (vol. 1, text, 1825), 87 pls. (vol. 2, plates, 1827).

Bruguière, M.
1789-1791. BALANITE, — *lepas;* Linn. Encyclopedie methodique: Histoire naturelle des Vers: 1 (1): 158-173 (text, 1789; plates, 1791).

Crisp, J. D., and B. S. Patel
1958. Relation between breeding and ecdysis in cirripedes. Nature 181: 1078-1079.
1960. The moulting cycle in *Balanus balanoides* L. Biol. Bull. 118 (1): 31-47.

Darwin, C. R.
1854. A monograph on the sub-class Cirripedia. The Balanidae, the Verrucidae, etc. London, Ray Society. 684 p.

Deshayes, G. P.
1831. CONIE. *Conia.* Encyclopedie methodique: Histoire naturelle des Vers 2 (2): 257-258.

Gmelin, J. F.
1791. Systema naturae per regna tri naturae . . . editio decima tertia, aucta, reformata. Leipzig 1 (6): 3021-3909 (Vermes).

Gray, J. E.
1825. A synopsis of the genera of cirripedes arranged in natural families, with a description of some new species. Ann. Philos., n.s. 10 (2): 97-107.

Gruvel, A.
1903. Revision des cirrhipedes appartenant a la collection du Museum D'Histoire Naturelle. Nouv. Arch. Mus. D'Hist. Nat., ser. 4 (5): 95-170.
1905. Monographie des cirrhipedes ou thecostraces. Paris, Masson et Cie. 472 p.

Henry, D. P.
1957. Some littoral barnacles from the Tuamotu, Marshall, and Caroline Islands. Proc. U.S. Natl. Mus. 107 (3381): 25-38.

Hiro, F.
1939. Studies on the cirripedian fauna of Japan. III. Supplementary notes on the cirripeds found in the vicinity of Seto. Mem. Coll. Sci., Kyoto Imp. Univ. ser. B, 15 (2): 237-284.

Hoek, P. P. C.
1907. The Cirripedia of the Siboga-Expedition. A. Cirripedia pedunculata. Siboga-Exped. 31: 1-127.

Jay, J. C.
1839. A catalogue of the shells, arranged according to the Lamarckian System, together with descriptions of new or rare species, contained in the collection of John C. Jay, M. D. New York, Wiley and Putnam. 125 p. 10 pls.

Krauss, F.
1848. Die SudaFrikanischen Mollusken. Stuttgart.

Lamarck, J. B. P. A. de M. de
1818. Histoire naturelle des animaux san vertebres 5: 375-410. Paris, Deterville.

Lamy, E. and M. Andre
1932. Notes sur les especes Lamarckiennes de Cirripedes. Compt. Rendu Cong. Soc. Sav. Paris Depart., Sec. Sci. 65: 212-228.

Martini, F. H. W., and J. H. Chemnitz
1785. Neues systematisches Conchylien-cabinet 8: 294-347, pl. 96-100.

Newman, W. A.
1967. A new genus of Chthamalidae (Cirripedia, Balanomorpha) from the Red Sea and Indian Ocean. J. Zool. London 153: 423-435.

Nilsson-Cantell, C. A.
1921. Cirripeden-Studien. Zur Kenntnis der Biologie, Anatomie und Systematik dieser Gruppe. Zool. Bidr. Uppsala 7: 75-395.
1939. Recent and fossil balanids from the north coast of South America. Cap. Zool. 8 (4): 1-7.

Patel, B., and D. J. Crisp
1961. Relation between the breeding and moulting cycles in cirripedes. Crustaceana 2 (2): 89-107.

Pilsbry, H. A.
1916. The sessile barnacles contained in the collection of the U.S. National Museum: including a monograph of the American species. Bull. U.S. Natl. Mus. 93: 1-366.
1927. Cirripedia of Curacao. Bijdr. Dierk. 25: 37-28.
1953. Notes on Floridan barnacles (Cirripedia). Proc. Acad. Nat. Sci. Philadelphia 105: 13-28.

Pope, E. C.
1943. Animal and plant communities of the coastal rock platform at Long Reef, New South Wales. Proc. Linnean Soc. New South Wales 68 (5-6): 221-254.
1945. A simplified key to the sessile barnacles found on the rocks, boats, wharf piles and other installations in Port Jackson and adjacent waters. Rec. Australian Mus. 21 (6): 351-372.
1965. A review of Australian and some Indomalayan Chthamalidae (Crustacea: Cirripedia). Proc. Linnean Soc. New South Wales 90 (1): 10-77.

Ranzani, C.
1818. Osservazioni su i Balanidi. Opuscoli Scientifici 2: 63-93.
1820. Osservazioni su i Balanidi. Mem. Storia Nat., deca prima: 13-57.

Ross, A.
1968. Bredin-Archbold-Smithsonian Biological survey of Dominica 8. The intertidal balanomorph Cirripedia. Proc. U.S. Natl. Mus. 125 (3663): 1-22.

Schmalz, C.
1906. Die ordnung der Cirripedien Systematische Conchylien-cabinet von Martini und Chemnitz II (27-28): 1-82. (published 1911).

Schumacher, C. F.
1817. Essai d'un nouveau systeme des habitations des vers testaces. Copenhagen. 287p.

Spengler, L.
1790. Beskrivelse og Oplysning over den hidindtil lidet udarbeijdede Slaegt af mangeskallede Konchylier, som Linnaeus har daldet Lepas, med tilføiede nye og ubeskrevne Arter. (Om Conchylie-Slaegten Lepas). Skrift. Naturhist. Selsk. 1 (1): 158-212.

Southward, A. J.
1962. On the behaviour of barnacles. IV. The influence of temperature on cirral activity and survival of some warm-water species. J. Marine Biol. Assoc. U.K. 42: 163-177.

Southward, A. J., and E. Southward
1958. On the occurrence and behaviour of two little-known barnacles, *Hexelasma hirsutum* and *Verruca recta*, from the continental slope. J. Marine Biol. Assoc. U.K. 37: 633-647.

Sowerby, G. B.
1823 [1821-1834]. The genera of Recent and Fossil shells. London. No pagination.

Weltner, W.
1897. Verzeichnis der bisher beschriebenen recenten Cirripedienarten. Arch. f. Naturgesch. 1 (3): 227-280.

Wood, W.
1815. General conchology; or a description of shells arranged according to the Linnean System. London. 246 p.

Zullo, V. A.
1968. *Tesseropora* Pilsbry (Cirripedia, Thoracica) from the Pliocene of the Gulf of California. Crustaceana 15 (3): 272-274.

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APPENDIX

MEASUREMENTS FOR *NEWMANELLA RADIATA*

Table 1. *Summary of data on cirral counts: range* (R) *and mean* (X) *values for the number of segments in anterior* (a) *and posterior* (p) *rami.*

		I		II		III		IV		V		VI	
		a	p	a	p	a	p	a	p	a	p	a	p
Bahamas	N	10	10	10	10	10	10	10	10	10	10	8	9
	R	18-23	10-15	7-9	12-19	8-12	11-24	20-24	20-24	19-25	20-25	24-26	22-26
	X	18.20	12.20	8.40	15.30	9.10	19.3	21.30	21.70	22.50	23.20	24.88	24.67
Vieques Sound Puerto Rico	N	8	8	8	7	8	7	6	6	6	6	4	6
	R	19-21	11-14	7-13	11-14	8-14	12-17	20-28	23-30	24-33	25-34	26-35	26-34
	X	19.75	12.00	10.37	12.71	11.62	14.57	24.00	27.00	28.00	29.66	29.75	30.16
Venezuela	N	5	7	8	8	8	7	8	7	7	7	7	8
	R	14-18	9-11	6-13	8-21	6-8	14-21	12-15	13-16	13-18	14-17	14-18	14-18
	X	16.00	10.00	8.00	13.25	7.25	18.42	13.38	14.43	15.14	15.14	16.14	16.25
Trinidad	N	8	8	8	8	8	5	8	9	8	7	7	9
	R	16-25	8-17	7-10	16-22	7-11	12-25	13-19	16-23	16-20	17-24	17-24	16-25
	X	21.00	13.62	8.75	18.50	9.00	19.00	16.38	19.00	18.50	19.85	19.85	19.88

Table 2. *Cirral counts for individual specimens.*

			I	II	III	IV	V	VI
Dominica								
	right	Anterior	19	9	11	14	17	15
		Posterior	13	17	21	13	15	14
	left	Anterior	18	9	9	12	14	14
		Posterior	12	16	11	12	13	14
Vieques Island, Puerto Rico								
	right	Anterior	22	12	15	27	37	37
		Posterior	14	20	23	34	37	36
	left	Anterior	22	13	15	26	33	27
		Posterior	15	19	18	31	38	39

Table 3. *Summary of data on shell and opercular valve parameters (in mm): range* (R) *and mean* (X) *values.*

		SHELL			OPERCULAR PLATES			
		Car-Ros			Scutum		Tergum	
		Diam.	Lat. Diam.	Height	Height	Width	Height	Width
Bahamas	R	9.3-17.2	9.5-16.5	5.9-13.3	2.5-4.8	2.5-4.9	3.4-6.1	2.3-4.5
(n = 5)	X	13.4	12.7	11.4	4.2	4.3	5.3	3.8
Vieques Sound, P.R.	R	12.9-23.1	13.3-24.6	7.5-13.9	4.6-6.6	4.1-7.0	6.1-9.5	4.3-7.6
(n = 4)	X	17.6	17.8	10.4	5.5	5.2	7.5	5.7
Venezuela	R	5.4-7.2	5.1-7.1	2.6-4.5				
(n = 6)	X	5.9	6.0	3.0				
Trinidad	R	11.1-14.9	9.4-14.5	6.1-14.7	3.0-6.8	2.7-6.1	3.5-7.4	2.6-5.0
(n = 5)	X	12.1	9.8	9.3	4.3	4.0	4.8	3.3
Dominica (n = 1)		10.0	8.1	7.8	3.1	2.9	3.5	2.6
Vieques Island, P.R. (n = 1)		31.3	29.3	28.1	10.1	10.5	13.1	13.9

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VOL. 15, NO. 16 3 OCTOBER 1969

TYPE SPECIMENS OF MAMMALS IN THE SAN DIEGO NATURAL HISTORY MUSEUM

Suzanne I. Bond

The mammal collections of the San Diego Society of Natural History comprise more than 21,000 specimens, of which the majority are from the southwestern United States and Baja California, Mexico. Included are holotypes of two species and 87 subspecies. In this catalog of type specimens, the following information is given: name as originally published, original citation, currently accepted name if different from the original, collector, date of collection, original number, museum number, and type locality. Unless otherwise specified, all taxa listed here were considered valid by Hall and Kelson (Mammals of North America. Ronald Press, New York, 1959). Geographic coordinates not given in the original description and corrected spelling are given in brackets. All holotype specimens are in good condition; skulls and skins are present for all.

The length of the list precluded the inclusion of paratypes. For a complete list, order NAPS Document 00310 from ASIS National Auxiliary Publications Service, c/o CCM Information Sciences, Inc., 22 West 34th Street, New York, New York 10001; remitting $1 for microfiche or $3 for photocopies.

FAMILY LEPORIDAE

Sylvilagus bachmani howelli Huey

San Diego Soc. Nat. Hist., Trans. 5 (5): 67-68, 6 July 1927.

Holotype. — Adult female. Collected by L. M. Huey, 10 December 1926. SDSNH no. 5939.

Type locality. — 10 mi SE Alamo, Baja California, Mexico; lat. 31°35′N, long. 116°03′W.

Sylvilagus bachmani rosaphagus Huey

San Diego Soc. Nat. Hist., Trans. 9 (23): 221-223, 31 July 1940.

Holotype. — Adult male. Collected by L. M. Huey, 2 June 1925. SDSNH no. 4947.

Type locality — 2 mi W Santo Domingo Mission, Baja California, Mexico; lat. 30°45′N, long. 115°58′W.

FAMILY SCIURIDAE

Ammospermophilus harrisii kinoensis Huey

San Diego Soc. Nat. Hist., Trans. 8 (25): 352-353, 15 June 1937.

= *Ammospermophilus harrisii saxicola* (Mearns)

Holotype. — Adult female. Collected by L. M. Huey, 22 February 1935. SDSNH no. 11284.

Type locality. — Bahia Kino, Sonora, Mexico [lat. 28°40′N, long. 111°58′W].

Remarks. — A. H. Howell (N. Amer. Fauna 56: 169, 1938) considered *A. h. kinoensis* a synonym of *A. h. saxicola.*

Ammospermophilus leucurus canfieldae Huey

San Diego Soc. Nat. Hist., Trans. 5 (15): 243-244, 27 February 1929.

Holotype. — Adult male. Collected by L. M. Huey, 14 February 1928. SDSNH no. 6873.

Type locality. — Punta Prieta, Baja California, Mexico; lat. 28°56′N, long. 114°12′W.

Citellus beecheyi nudipes Huey
San Diego Soc. Nat. Hist., Trans. 7 (2): 18-20, 6 October 1931.
= *Spermophilus beecheyi nudipes* (Huey)
Holotype. — Adult female. Collected by F. Stephens, 13 October 1926. SDSNH no. 2015.
Type locality. — Laguna Hanson, Sierra Juarez, Baja California, Mexico; lat. 31°58'N, long. 115°53'W.
Remarks. — The Committee on Nomenclature, American Society of Mammalogists recommended the use of *Spermophilus* to replace *Citellus* (J. Mamm. 49 (3): 605, 1968).

Citellus beecheyi rupinarum Huey
San Diego Soc. Nat. Hist., Trans. 7 (2): 17-18, 6 October 1931
= *Spermophilus beecheyi rupinarum* (Huey)
Holotype. — Sub-adult female. Collected by L. M. Huey, 9 October 1930. SDSNH no. 8251.
Type locality. — Catavina, Baja California, Mexico; lat. 29°54'N, long. 114°57'W.

Citellus tereticaudus apricus Huey
San Diego Soc. Nat. Hist. Trans. 5 (7): 85-86, 10 October 1927.
= *Spermophilus tereticaudus apricus* (Huey)
Holotype. — Adult male. Collected by L. M. Huey, 13 July 1927. SDSNH no. 6308.
Type locality. — Valle de la Trinidad, Baja California, Mexico; lat. 31°20'N, long. 115°40'W.

Citellus tereticaudus vociferans Huey
Proc. Biol. Soc. Wash. 39: 29-30, 30 July 1926.
= *Spermophilus tereticaudus tereticaudus* Baird
Holotype. — Adult female. Collected by L. M. Huey, 25 March 1926. SDSNH no. 5127.
Type locality. — San Felipe, Baja California, Mexico [lat. 31°02'N, long. 114°50'W].
Remarks. — A. H. Howell (N. Amer. Fauna 56: 185, 1938) considered *C. t. vociferans* a synonym of *C. t. tereticaudus*.

FAMILY GEOMYIDAE

Thomomys bottae abbotti Huey
San Diego Soc. Nat. Hist., Trans. 5 (8): 89-90, 18 January 1928.
= *Thomomys umbrinus abbotti* Huey
Holotype. — Adult male. Collected by L. M. Huey, 10 May 1925. SDSNH no. 4781.
Type locality. — 1 mi E El Rosario, Baja California, Mexico; lat. 30°03'N, long. 115°48'W.
Remarks. — Hall & Kelson (Mamm. N. Amer. 1: 416, 1959) considered *bottae* conspecific with *umbrinus*. See also Patton & Dingman, J. Mamm., 49 (1): 1-13, 1968.

Thomomys bottae affinis Huey
San Diego Soc. Nat. Hist., Trans. 10 (14): 254-255, 31 August 1945.
= *Thomomys umbrinus affinis* Huey
Holotype. — Adult male. Collected by L. M. Huey, 9 May 1940. SDSNH no. 14083.
Type locality. — Jacumba, San Diego County, California.

Thomomys argusensis Huey
San Diego Soc. Nat. Hist., Trans. (5): 43-44, 19 December 1931.
= *Thomomys umbrinus argusensis* Huey
Holotype. — Adult male. Collected by S. G. Harter, 10 August 1931. SDSNH no. 9545.
Type locality. — Junction Ranch, Argus Mts., Inyo County, California.

Thomomys bottae aridicola Huey

San Diego Soc. Nat. Hist., Trans. 8 (25): 354-355, 15 June 1937.

= *Thomomys umbrinus aridicola* Huey

Holotype. — Adult female. Collected by L. M. Huey, 1 February 1936. SDSNH no. 11424.

Type locality. — 10 mi S Gila Bend, Maricopa County, Arizona, about 2 mi N of Black Gap.

Thomomys bottae boregoensis Huey

San Diego Soc. Nat. Hist., Trans. 9 (15): 70-71, pl. 5, Figure D, 8 December 1939.

= *Thomomys umbrinus boregoensis* Huey

Holotype. — Adult female. Collected by L. M. Huey, 29 March 1930. SDSNH no. 8034.

Type locality. — Beatty Ranch, Borego [= Borrego] Valley, San Diego County, California.

Thomomys bottae aderrans Huey

San Diego Soc. Nat. Hist., Trans. 9 (15): 71-72, pl. 5, Figure E, 8 December 1939.

= *Thomomys umbrinus boregoensis* Huey

Holotype. — Adult female. Collected by F. Stephens , 21 January 1924. SDSNH no. 1305.

Type locality. — Carrizo Creek, San Diego County, California.

Remarks. — J. E. Chattin (San Diego Soc. Nat. Hist., Trans. 9 (27): 275-277, 1941) considered *T. b. aderrans* a synonym of *T. u. boregoensis.*

Thomomys bottae borjasensis Huey

San Diego Soc. Nat. Hist., Trans. 10 (14): 262-263, 31 August 1945.

= *Thomomys umbrinus borjasensis* Huey

Holotype. — Adult female. Collected by L. M. Huey, 14 October 1941. SDSNH no. 14491.

Type locality. — San Borjas [= Borja] Mission, Baja California, Mexico; lat. 28°52′n, long. 113°53′W.

Thomomys umbrinus brazierhowelli Huey

San Diego Soc. Nat. Hist., Trans. 12 (23): 407-408, 1 February 1960.

Holotype. — Adult male. Collected by A. B. Howell, 26 February 1958. SDSNH no. 18725.

Type locality. — San Fernando Mission, Baja California, Mexico [lat. 29°58′N, long. 115°15′W].

Thomomys bottae cactophilus Huey

San Diego Soc. Nat. Hist., Trans. 5 (15): 241-242, 27 February 1929.

= *Thomomys umbrinus cactophilus* Huey

Holotype. — Adult male. Collected by L. M. Huey, 17 February 1928. SDSNH no. 6808.

Type locality. — Punta Prieta, Baja California, Mexico; lat. 28°56′N, long. 114°12′W.

Thomomys bottae catavinensis Huey

San Diego Soc. Nat. Hist., Trans. 7 (5): 45, 19 December 1937.

= *Thomomys umbrinus catavinensis* Huey

Holotype. — Adult female. Collected by L. M. Huey, 10 October 1930. SDSNH no. 8256.

Type locality. — Catavina, Baja California, Mexico; lat. 29°54′N, long. 114°57′W.

Thomomys bottae cedrinus Huey
San Diego Soc. Nat. Hist., Trans. 12 (6): 100-101, 10 February 1955.
= *Thomomys umbrinus cedrinus* Huey
Holotype. — Adult female. Collected by L. M. Huey, 27 April 1938. SDSNH no. 13161.
Type locality. — From summit of Crossman Peak, Chemehuevis Mts.; Mohave County, Arizona.

Thomomys bottae comobabiensis Huey
San Diego Soc. Nat. Hist., Trans. 8 (25): 354, 15 June 1937.
= *Thomomys umbrinus comobabiensis* Huey
Holotype. — Adult female. Collected by L. M. Huey, 22 March 1937. SDSNH no. 12460.
Type locality. — 5 mi NW Sells, Pima County, Arizona.

Thomomys bottae cunicularius Huey
San Diego Soc. Nat. Hist., Trans. 10 (14): 252-253, 31 August 1945.
= *Thomomys umbrinus cunicularius* Huey
Holotype. — Adult male. Collected by L. M. Huey, 29 November 1936. SDSNH no. 12182.
Type locality. — Los Palmitos, SE base of Sierra Juarez, Baja California, Mexico; lat. 31°44′N, long. 115°36′W.

Thomomys bottae growlerensis Huey
San Diego Soc. Nat. Hist., Trans. 8 (25): 353-354, 15 June 1937.
= *Thomomys umbrinus growlerensis* Huey
Holotype. — Adult male. Collected by L. M. Huey, 16 March 1937. SDSNH no. 12387.
Type locality. — 7 mi E Papago Well, Pima County, Arizona.

Thomomys bottae homorus Huey
San Diego Soc. Nat. Hist., Trans. 11 (4): 55, 31 January 1949.
= *Thomomys umbrinus homorus* Huey
Holotype. — Adult male. Collected by L. M. Huey, 6 April 1947. SDSNH no. 15689.
Type locality. — 1 mi E Rancho Lagunita, Baja California, Mexico; lat. 28°20′N, long. 113°15′W.

Thomomys bottae hueyi Goldman
Wash. Acad. Sci. 28: 340-341, 15 July 1938.
= *Thomomys umbrinus hueyi* Goldman
Holotype. — Adult male. Collected by L. M. Huey, 17 June 1932. SDSNH no. 10088.
Type locality. — Spud Rock Ranger Station, 7400 ft., Rincon Mts., Pima County, Arizona.

Thomomys bottae jojobae Huey
San Diego Soc. Nat. Hist., Trans. 10 (14): 256-257, 31 August 1945.
= *Thomomys umbrinus jojobae* Huey
Holotype. — Adult male. Collected by L. M. Huey, 20 June 1927. SDSNH no. 6116.
Type locality. — Sangre de Cristo, Baja California, Mexico; lat. 31°52′N, long. 116°06′W.

Thomomys bottae juarezensis Huey
San Diego Soc. Nat. Hist., Trans. 10 (14): 255-256, 31 August 1945.
= *Thomomys umbrinus juarezensis* Huey
Holotype. — Adult male. Collected by L. M. Huey, 6 November 1936. SDSNH no. 5849.

Type locality. — Laguna Hanson, Sierra Juarez, Baja California, Mexico [lat. 31°58′N, long. 115°53′W].

Thomomys bottae lorenzi Huey

San Diego Soc. Nat. Hist., Trans. 9 (22): 219-220, 31 July 1940.

= *Thomomys umbrinus lorenzi* Huey

Holotype. — Adult male. Collected by P. Covel, 17 April 1933. Original no. 175, now SDSNH no. 10608.

Type locality. — 7 mi N Boulder Creek, Santa Cruz County, California.

Thomomys bottae proximarinus Huey

San Diego Soc. Nat. Hist., Trans. 10 (14): 261, 31 August 1945.

= *Thomomys umbrinus proximarinus* Huey

Holotype. — Adult male. Collected by L. M. Huey, 15 August 1940. SDSNH no. 14182.

Type locality. — Boca la Playa, 16 mi W Santo Tomas, Baja California, Mexico; lat. 31°32′N, long. 116°38′W.

Thomomys bottae rhizophagus Huey

San Diego Soc. Nat. Hist., Trans. 11 (4): 54-55, 31 January 1949.

= *Thomomys umbrinus rhizophagus* Huey

Holotype. — Adult male. Collected by L. M. Huey, 11 April 1947. SDSNH no. 15710.

Type locality. — Las Flores, 7 mi S of Bahia de Los Angeles, Baja California, Mexico; lat. 28°50′N, long. 113°32′W.

Thomomys bottae ruricola Huey

San Diego Soc. Nat. Hist., Trans. 11 (4): 53-54, 31 January 1949.

= *Thomomys umbrinus ruricola* Huey

Holotype. — Adult male. Collected by L. M. Huey, 27 June 1947. SDSNH no. 15944.

Type locality. — 4 mi N Santa Catarina Landing, Baja California, Mexico; lat. 29°35′N, long. 115°17′W.

Thomomys bottae sanctidiegi Huey

San Diego Soc. Nat. Hist., Trans. 10 (14): 258-259, 31 August 1945.

= *Thomomys umbrinus sanctidiegi* Huey

Holotype. — Adult male. Collected by L. M. Huey, 18 December 1941. SDSNH no. 14886.

Type locality. — Balboa Park, San Diego [San Diego County], California.

Thomomys bottae vanrossemi Huey

San Diego Soc. Nat. Hist., Trans. 8 (1): 1-2, 10 August 1934.

= *Thomomys umbrinus vanrossemi* Huey

Holotype. — Adult male. Collected by L. M. Huey, 15 February 1934. SDSNH no. 10922.

Type locality. — Punta Penascosa, Sonora, Mexico [lat. 31°25′N, long. 113°35′W].

Thomomys bottae xerophilus Huey

San Diego Soc. Nat. Hist., Trans. 10 (14): 257, 31 August 1945.

= *Thomomys umbrinus xerophilus Huey*

Holotype. — Adult male. Collected by L. M. Huey, 29 March 1936. SDSNH no. 11827.

Type locality. — Near Diablito Spring, summit of San Matias Pass (between Sierra Juarez & Sierra San Pedro Martir), Baja California, Mexico [near lat. 31°20′N, long. 115°30′W].

Thomomys quadratus monoensis Huey

San Diego Soc. Nat. Hist., Trans. 7 (35): 373-374, 31 May 1934.

= *Thomomys talpoides monoensis* Huey
Holotype. — Adult male. Collected by L. M. Huey, 7 August 1932. SDSNH no. 10414.
Type locality. — Dexter Creek Meadow, at confluence of Dexter and Wet Creeks, Mono County, California.
Remarks. — Goldman (J. Mamm. 20: 234, 1939) considered *T. q. monoensis* a synonym of *T. t. monoensis.*

FAMILY HETEROMYIDAE

Perognathus longimembris aestivus Huey
San Diego Soc. Nat. Hist., Trans. 5 (8): 87-89, 18 January 1928.
Holotype. — Adult male. Collected by L. M. Huey, 20 June 1937. SDSNH no. 6110.
Type locality. — Sangre de Cristo in Valle San Rafael on W base of Sierra Juarez, Baja California, Mexico; lat. 31°52′N, long. 116°06′W.

Perognathus longimembris internationalis Huey
San Diego Soc. Nat. Hist., Trans. 9 (11): 47-50, 31 August 1939.
Holotype. — Adult male. Collected by L. M. Huey, 24 April 1936. SDSNH no. 11972.
Type locality. — Baja California side of the International Boundary at Jacumba, San Diego County, California.

Perognathus longimembris kinoensis Huey
San Diego Soc. Nat. Hist., Trans. 8 (12): 73-74, 24 August 1935.
Holotype. — Adult male. Collected by L. M. Huey, 26 February 1935. SDSNH no. 11300.
Type locality. — Bahia Kino, Sonora, Mexico [lat. 28°40′N, long. 111°58′W].

Perognathus longimembris pimensis Huey
San Diego Soc. Nat. Hist., Trans. 8 (25): 355-357, 15 June 1937.
Holotype. — Adult male. Collected by L. M. Huey, 22 May 1937. SDSNH no. 12579.
Type locality. — 11 mi W Casa Grande, Pinal County, Arizona.

Perognathus longimembris venustus Huey
San Diego Soc. Nat. Hist., Trans. 6 (17): 233, 24 December 1930.
Holotype. — Adult female. Collected by L. M. Huey, 4 October 1930. SDSNH no. 8196.
Type locality. — San Agustin, Baja California, Mexico; lat. 30°N, long. 115°W.

Perognathus longimembris virginis Huey
San Diego Soc. Nat. Hist., Trans. 9 (12): 55-56, 31 August 1939.
Holotype. — Adult male. Collected by L. M. Huey, 12 August 1937. SDSNH no. 12919.
Type locality. — St. George, 2950 ft., Washington County, Utah.

Perognathus alticola inexpectatus Huey
Proc. Biol. Soc. Wash. 39: 121-122, 27 December 1926.
Holotype. — Adult male. Collected by G. Cantwell, 28 August 1936. Original no. 216, now SDSNH no. 5724.
Type locality. — 14 mi W Lebec, Kern County, California.

Perognathus formosus infolatus Huey
San Diego Soc. Nat. Hist., Trans. 12 (1): 1-2, 1 March 1954.
Holotype. — Adult male. Collected by L. M. Huey, 3 April 1947. SDSNH no. 15664.
Type locality. — 7 mi W San Francisquito Bay, Gulf of California, Baja California, Mexico; lat. 28°30′N, [long. 113°W].

Perognathus formosus mohavensis Huey
San Diego Soc. Nat. Hist., Trans. 9 (8): 35-36, 21 November 1938.

Holotype. — Adult male. Collected by L. M. Huey, 14 April 1935. SDSNH no. 11317.
Type locality. — Bonanza King Mine, Providence Mts., San Bernardino County, California.

Perognathus baileyi hueyi Nelson & Goldman
Proc. Bio. Soc. Wash. 42: 106-107, 25 March 1929.
Holotype. — Adult female. Collected by L. M. Huey, 17 April 1926. SDSNH no. 5220.
Type locality. — San Felipe, Baja California, Mexico [lat. 31°02′N, long. 114°50′W].

Perognathus baileyi mesidios Huey
San Diego Soc. Nat. Hist., Trans. 13 (7): 112, 15 January 1964.
Holotype. — Adult male. Collected by L. M. Huey, 13 October 1941. SDSNH no. 14470.
Type locality. — San Borja Mission, Baja California, Mexico; lat. 28°45′N [long. 113°50′W].

Perognathus arenarius albescens Huey
Proc. Biol. Soc. Wash. 39: 67-69, 30 July 1926.
Holotype. — Adult male. Collected by L. M. Huey, 23 March 1926. SDSNH no. 5103.
Type locality. — San Felipe, Baja California, Mexico [lat. 31°02′N, long. 114°50′W].

Perognathus arenarius mexicalis Huey
San Diego Soc. Nat. Hist., Trans. 9 (13): 57-58, 31 August 1939.
Holotype. — Adult female. Collected by L. M. Huey, 23 November 1936. SDSNH no. 12127.
Type locality. — Los Muertos Canyon fan, Gaskill's Tank, near Laguna Salada, Baja California, Mexico; lat. 32°27′N, long. 115°53′W.

Perognathus arenarius paralios Huey
San Diego Soc. Nat. Hist., Trans. 13 (7): 113, 15 January 1964.
Holotype. — Adult male. Collected by L. M. Huey, 23 March 1926. SDSNH no. 15542.
Type locality. — Barril, Baja California, Mexico; lat. 28°20′N [long. 112°50′W].

Perognathus arenarius sabulosus Huey
San Diego Soc. Nat. Hist., Trans. 13 (7): 114, 15 January 1964.
Holotype. — Adult male. Collected by L. M. Huey, 22 May 1926. SDSNH no. 5300.
Type locality. — From mainland on the S side of Scammon's Lagoon, Baja California, Mexico [near lat. 27°40′N, long. 114°05′W].

Perognathus intermedius lithophilus *Huey*
San Diego Soc. Nat. Hist., Trans. 8 (25): 355, 15 June 1937.
Holotype. — Adult male. Collected by L. M. Huey, 5 February 1935. SDSNH no. 11211.
Type locality. — Porto [= Puerto] Libertad, Sonora, Mexico [lat. 29°57′N, long. 112°40′W].

Perognathus fallax majusculus Huey
San Diego Soc. Nat. Hist., Trans. 12 (25): 418, 1 February 1960.
Holotype. — Adult male. Collected by L. M. Huey, 29 June 1947. SDSNH no. 15952.
Type locality. — San Quintin, Baja California, Mexico [lat. 30°30′N, long. 115°59′W].

Perognathus fallax xerotrophicus Huey
San Diego Soc. Nat. Hist., Trans. 12 (25): 419, 1 February 1960.
Holotype. — Adult male. Collected by L. M. Huey, 15 October 1930. SDSNH no. 8310.
Type locality. — 2 mi NW Chapala, Baja California, Mexico [lat. 29°25′N, long. 114°20′W].

Perognathus spinatus broccus Huey

San Diego Soc. Nat. Hist., Trans. 12 (24): 410, 1 February 1960.

Holotype. — Adult male. Collected by L. M. Huey, 18 March 1928. SDSNH no. 6891.

Type locality. — San Ignacio, Baja California, Mexico; lat. 27°17′N [long. 112°55′W].

Perognathus spinatus lorenzi Banks

Pro. Biol. Soc. Wash. 80: 101-103, 28 July 1967.

Holotype. — Adult male. Collected by R. C. Banks, 22 October 1964. Original no. RCB-2366, now SDSNH no. 19901.

Type locality. — South San Lorenzo Island, Gulf of California, Baja California, Mexico; lat. 23°36′N, long. 112°51′W.

Perognathus spinatus oribates Huey

San Diego Soc. Nat. Hist., Trans. 12 (24): 409-410, 1 February 1960.

Holotype. — Adult male. Collected by L. M. Huey, 27 February 1958. SDSNH no. 18742.

Type locality. — San Fernando Mission, Baja California, Mexico; lat. 30°N [long. 115°15′W].

Perognathus spinatus prietae Huey

San Diego Soc. Nat. Hist., Trans. 6 (17): 232-233, 24 December 1930.

Holotype. — Adult male. Collected by L. M. Huey, 26 October 1930. SDSNH no. 8450.

Type locality. — 25 mi N Punta Prieta, Baja California, Mexico; lat. 29°24′N, long. 114°24′W.

Perognathus spinatus rufescens Huey

San Diego Soc. Nat. Hist., Trans. 6 (17): 231-232, 24 December 1930.

Holotype. — Adult male. Collected by L. M. Huey, 10 November 1929. SDSNH no. 7446.

Type locality. — Mouth of Palm Canyon, Borego [= Borrego] Valley, San Diego County, California.

Dipodomys mohavensis argusensis Huey

San Diego Soc. Nat. Hist., Trans. 10 (10): 131-132, 9 March 1945.

= *Dipodomys panamintinus argusensis* Huey

Holotype. — Adult male. Collected by S. G. Harter, 13 August 1931. Original no. 140, now SDSNH no. 9552.

Type locality. — Junction Ranch, 5725 ft., Argus Mts., Inyo County, California.

Remarks. — Miller and Kellog (Bull. U.S. Nat. Mus. 205: 387, 3 March 1955) considered *D. m. argusensis* a synonym of *D. p. argusensis.*

Dipodomys cascus Huey

San Diego Soc. Nat. Hist., Trans. 12 (29): 479-480, 30 August 1962.

= *Dipodomys stephensi* (Merriam)

Holotype. — Adult male. Collected by L. M. Huey, 17 August 1961. SDSNH no. 18961.

Type locality. — 1 mi E Bonsall, San Diego County, California.

Remarks. — Lackey (San Diego Soc. Nat. Hist., Trans. 14 (22): 328, 1967) considered *D. cascus* a synonym of *D. stephensi.*

Dipodomys agilis martirensis Huey

San Diego Soc. Nat. Hist., Trans. 5 (1): 7-8, 20 February 1927.

Holotype. — Adult male. Collected by L. M. Huey, 28 September 1926. SDSNH no. 5762.

Type locality. — La Grulla (east side of the valley), Sierra San Pedro Martir, Baja

California, Mexico [lat. 30°50′N, long. 115°20′W].

Dipodomys agilis plectilis Huey

San Diego Soc. Nat. Hist., Trans. 11 (10): 240, 30 April 1951.

Holotype. — Adult female. Collected by L. M. Huey, 1 May 1925. SDSNH no. 4721.

Type locality. — Mouth of Canyon San Juan de Dios, Baja California, Mexico; lat. 30°7′N, [long. 115°10′W].

Dipodomys agilis latimaxillaris Huey

Pro. Biol. Soc. Wash. 38: 84, 26 May 1925.

= *Dipodomys agilis simulans* (Merriam)

Holotype. — Adult male. Collected by L. M. Huey, 27 February 1925. SDSNH no. 4696.

Type locality. — 2 mi W Santo Domingo Mission, Baja California, Mexico; lat. 30°45′N, long. 115°58′W.

Remarks. — Huey (San Diego Soc. Nat. Hist., Trans. 11 (10): 234, 1951) later considered *D. a. latimaxillaris* a synonym of *D. a. simulans.*

Dipodomys parlius Huey

San Diego Soc. Nat. Hist., Trans. 11 (10): 241, 30 April 1951.

Holotype. — Adult male. Collected by L. M. Huey, 13 April 1923. SDSNH no. 4250.

Type locality. — Santa Catarina Landing, Baja California, Mexico; lat. 29°31′N [long. 115°20′W].

Dipodomys peninsularis australis Huey

San Diego Soc. Nat. Hist., Trans. 11 (1): 249, 30 April 1951.

Holotype. — Adult male. Collected by L. M. Huey, 21 November 1941. SDSNH no. 14734.

Type locality. — Santo Domingo, Magdalena Plain, Baja California, Mexico; lat. 25°30′N [long. 112°07′W].

Dipodomys peninsularis eremoecus Huey

San Diego Soc. Nat. Hist., Trans. 11 (10): 248-249, 30 April 1951.

Holotype. — Adult male. Collected by L. M. Huey, 31 March 1947. SDSNH no. 15619.

Type locality. — 7 mi W San Francisquito Bay, Gulf of California, Baja California, Mexico; lat. 28°30′N [long. 112°58′W].

Dipodomys peninsularis pedionomus Huey

San Diego Soc. Nat. Hist., Trans. 11 (10): 247-248, 30 April 1951.

Holotype. — Adult male. Collected by L. M. Huey, 17 October 1930. SDSNH no. 8363.

Type locality. — 2 mi N [label says NW] Chapala Dry Lake, on Llano Santa Ana, Baja California, Mexico; lat. 29°30′N, long. 114°35′W.

Dipodomys gravipes Huey

Pro. Biol. Soc. Wash. 38:83-84, 26 May 1925.

Holotype. — Adult male. Collected by L. M. Huey, 28 February 1925. SDSNH no. 4703.

Type locality. — 2 mi W Santo Domingo Mission, Baja California, Mexico; lat. 30°45′N, long. 115°58′W.

Dipodomys antiquarius Huey

San Diego Soc. Nat. Hist., Trans. 12 (29): 477-479, 30 August 1962.

Holotype. — Adult female. Collected by G. Ives, 30 March 1960. SDSNH no. 18901.

Type locality. — San Juan Mine, Sierra San Borja, Baja California, Mexico; lat. 28°50′N, long. 113°37′W.

Dipodomys merriami annulus Huey

San Diego Soc. Nat. Hist., Trans. 11 (10): 224-225, 30 April 1951.

Holotype. — Adult female. Collected by L. M. Huey, 22 March 1947. SDSNH no. 15522.

Type locality. — Barril, Gulf of California, Baja California, Mexico; lat. 28°20′N, long. 112°50′W.

Dipodomys merriami brunensis Huey

San Diego Soc. Nat. Hist., Trans. 11 (10): 225-226, 30 April 1951.

Holotype. — Adult male. Collected by L. M. Huey, 28 March 1928. SDSNH no. 6904.

Type locality. — Llano de San Bruno, Baja California, Mexico [lat. 26°15′N, long. 111°35′W].

Dipodomys merriami llanoensis Huey

San Diego Soc. Nat. Hist., Trans. 11 (10): 226-227, 30 April 1951.

Holotype. — Adult male. Collected by L. M. Huey, 15 November 1941. SDSNH no. 14676.

Type locality. — Buena Vista, Magdalena Plain, Baja California, Mexico; lat. 24°51′N, long. 111°50′W.

Dipodomys merriami quintinensis Huey

San Diego Soc. Nat. Hist., Trans. 11 (10): 222-223, 30 April 1951.

Holotype. — Adult male. Collected by L. M. Huey, 9 April 1923. SDSNH no. 4205.

Type locality. — 5 mi E San Quintin, Baja California, Mexico [lat. 30°30′N, long. 115°50′W].

Dipodomys merriami semipallidus Huey

San Diego Soc. Nat. Hist., Trans. 5 (5): 65-66, 6 July 1927.

Holotype. — Adult female. Collected by L. M. Huey, 15 April 1923. SDSNH no. 4271.

Type locality. — 7 mi N Santa Catarina, Baja California, Mexico; lat. 29°45′N, long. 115°10′W.

Dipodomys merriami trinidadensis Huey

San Diego Soc. Nat. Hist., Trans. 11 (10): 220-221, 30 April 1951.

Holotype. — Adult male. Collected by L. M. Huey, 13 March 1936. SDSNH no. 11531.

Type locality. — Aguajito Spring, El Valle de la Trinidad, Baja California, Mexico [near lat. 31°28′N, long. 115°40′W].

Dipodomys deserti arizonae Huey

San Diego Soc. Nat. Hist., Trans. 12 (6): 99-100, 10 February 1955.

Holotype. — Adult male. Collected by L. M. Huey, 14 May 1937. SDSNH no. 12532.

Type locality. — 3 mi SE Picacho, Pinal County, Arizona.

FAMILY CRICETIDAE

Peromyscus crinitus pallidissimus Huey

San Diego Soc. Nat. Hist., Trans. 6 (26): 389-390, 28 August 1931.

Holotype. — Adult male. Collected by A. W. Anthony, 21 November 1930. Original no. 1175, now SDSNH no. 8864.

Type locality. — Small island in Gonzaga Bay, Baja California, Mexico; lat. 29°50′N, long. 114°20′W.

Peromyscus guardia harbisoni Banks

J. Mamm. 48 (2): 215, 20 May 1967.

Holotype. — Adult male. Collected by C. F. Harbison, 23 March 1963. Original no. RCB-1607, now SDSNH no. 19194.

Type locality. — Isla Granite, Gulf of California, Baja California, Mexico; lat. 29°33′N, long. 113°34′W.

Peromyscus interparietalis lorenzi Banks

J. Mamm. 48 (2): 216, 20 May 1967.

Holotype. — Adult male. Collected by R. C. Banks, 23 October 1964. Original no. RCB-2282, now SDSNH no. 19912.

Type locality. — Isla San Lorenzo Norte, Gulf of California, Baja California, Mexico; lat. 28°42′N, long. 112°57′W.

Peromyscus interparietalis ryckmani Banks

J. Mamm. 48 (2): 216, 20 May 1967.

Holotype. — Adult female. Collected by R. C. Banks, 23 October 1964. Original no. RCB-2335, now SDSNH no. 19944.

Type locality. — Isla Salsipuedes, Gulf of California, Baja California, Mexico; lat. 28°42′N, long. 112°59′W.

Peromyscus maniculatus hueyi Nelson and Goldman

San Diego Soc. Nat. Hist., Trans. 7 (7): 51-52, 15 April 1932.

Holotype. — Adult male. Collected by A. W. Anthony, 21 November 1930. Original no. 1172, now SDSNH no. 8861.

Type locality. — Small island in Gonzaga Bay, Baja California, Mexico; lat. 20°15′N [long. 114°20′W].

Neotoma lepida aridicola Huey

San Diego Soc. Nat. Hist., Trans. 12 (15): 287-288, 25 September 1957.

Holotype. — Adult male. Collected by L. M. Huey, 27 March 1947. SDSNH no. 15595.

Type locality. — El Barril, Gulf of California, Baja California, Mexico; lat. 28°20′N [long. 112°50′W].

Neotoma lepida aureotunicata Huey

San Diego Soc. Nat. Hist., Trans. 8 (25): 349-350, 15 June 1937.

Holotype. — Adult male. Collected by L. M. Huey, 14 February 1934. SDSNH no. 10907.

Type locality. — Punta Penascosa, Sonora, Mexico [lat. 31°20′N, long. 113°40′W].

Neotoma lepida harteri Huey

San Diego Soc. Nat. Hist., Trans. 8 (25): 351-352, 15 June 1937.

Holotype. — Adult male. Collected by L. M. Huey, 8 February 1936. SDSNH no. 11462.

Type locality. — 10 mi S Gila Bend (2 mi N Black Gap), Maricopa County, Arizona.

Neotoma lepida molagrandis Huey

San Diego Soc. Nat. Hist., Trans. 10 (16): 307-310, 31 August 1945.

Holotype. — Adult male. Collected by L. M. Huey, 28 April 1940. SDSNH no. 14065.

Type locality. — Santo Domingo Landing, some 3 mi inland from the beach landing, Baja California, Mexico; lat. 28°15′N [long. 114°02′W].

Phenacomys silvicolus A. B. Howell

J. Mamm. 2: 98-100. pl. 7, 2 May 1921.

= *Phenacomys silvicola* A. B. Howell

Holotype. — Young adult female. Collected by P. Walker, 25 October 1916. Originally of the S. G. Jewett Coll., no. 1214, now SDSNH no. 16437.

Type locality. — 5 mi SE Tillamook, Tillamook County, Oregon.

Microtus californicus grinnelli Huey

San Diego Soc. Nat. Hist., Trans. 7 (6): 47-49, 19 December 1931.

Holotype. — Adult male. Collected by L. M. Huey, 26 June 1927. SDSNH no. 6165.

Type locality. — Sangre de Cristo in Valle San Rafael on the W base of the Sierra Juarez, Baja California, Mexico; lat. 31°52′N, long. 116°06′W.

Ondatra zibethicus goldmani Huey

San Diego Soc. Nat. Hist., Trans. 8 (32): 409-410, 18 January 1938.

Holotype. — Adult female. Collected by L. M. Huey, 11 August 1937. SDSNH no. 12915.

Type locality. — Saint George, Washington County, Utah.

FAMILY CANIDAE

Urocyon cinereoargenteus peninsularis Huey

San Diego Soc. Nat. Hist., Trans. 5 (13): 205-207, pl. 25, Figure 1, pl. 26, Figure 3, 1 September 1928.

Holotype. — Adult male. Collected by L. M. Huey, 10 March 1928. SDSNH no. 6845.

Type locality. — San Ignacio, Baja California, Mexico; lat. 27°24′N, long. 112°59′W.

FAMILY PROCYONIDAE

Bassariscus astitus yumanensis Huey

San Diego Soc. Nat. Hist., Trans. 8 (25): 357-359, pl. 23, 15 June 1937.

Holotype. — Adult male. Collected by L. M. Huey, 6 March 1937. SDSNH no. 12272.

Type locality. — Tinajas Atlas, Gila Mts., Yuma County, Arizona.

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TWELVE NEW DICOTS FROM BAJA CALIFORNIA, MEXICO

REID MORAN

TRANSACTIONS

OF THE SAN DIEGO
SOCIETY OF
NATURAL HISTORY

VOL. 15, NO. 17 15 OCTOBER 1969

TWELVE NEW DICOTS FROM BAJA CALIFORNIA, MEXICO

REID MORAN

ABSTRACT. — Described are *Hedeoma martirense*, *Heterotheca martirensis*, *Stephanomeria monocephala*, and *Tanacetum bajacalifornicum*, from the high east face of the Sierra San Pedro Mártir; *Eriogonum zapatoense* and *Castilleja fruticosa*, from Isla Guadalupe; *Eriogonum angelense*, from Isla Angel de la Guarda; *Dudleya nubigena* (Brandegee) Britt. & Rose ssp. *cerralvensis*, from Isla Cerralvo; *Hemizonia greeneana* Rose ssp. *peninsularis*, from Islas de Todos Santos and the nearby coast; *Monardella lagunensis* M. E. Jones ssp. *mediopeninsularis*, from four peaks in central Baja California; *Rhus kearneyi* Barkley ssp. *borjaensis*, from the Sierra San Borja; and *Rhus kearneyi* ssp. *virginum*, from the mountains of south central Baja California.

RESUMEN. — Se describen doce taxa nuevos de Dicotiledóneas procedentes de Baja California, Mexico: *Hedeoma martirense*, *Heterotheca martirensis*, *Stephanomeria monocephala*, y *Tanacetum bajacalifornicum*, de la alta escarpadura oriental de la Sierra de San Pedro Mártir; *Eriogonum zapatoense* y *Castilleja fruticosa*, de la Isla Guadalupe; *Eriogonum angelense*, de la Isla Angel de la Guarda; *Dudleya nubigena* (Brandegee) Britt. y Rose ssp. *cerralvensis*, de la Isla Cerralvo; *Hemizonia greeneana* Rose ssp. *peninsularis*, de las Islas de Todos Santos y costas cercanas; *Monardella lagunensis* M. E. Jones ssp. *mediopeninsularis*, de cuatro cerros de la parte central de Baja California; *Rhus kearneyi* Barkley ssp. *borjaensis*, de la Sierra San Borja; y *Rhus kearneyi* ssp. *virginum*, de las sierras centro-meridionales de Baja California.

In the course of general collecting in Baja California, I have found several previously unknown plants, twelve of which are described here. In the citation of collections, field numbers are mine unless otherwise identified. Each of my recent collections (above number 5000) is represented in the herbarium of the San Diego Society of Natural History. Duplicates now being distributed are mostly not cited; they will go to the herbaria of the Smithsonian Institution, in Washington, the Universidad Nacional Autonoma de Mexico, in Mexico City, the University of California at Berkeley, and various other institutions.

Eriogonum angelense Moran, spec. nov. (Fig. 1)

Planta perennis, caudice pauciramoso, erecto, 1-6 dm alto, rosula densa 2-3 ½ dm lata coronato. Folia hirtella, ¾-2 dm longa, lamina ovata, cordata, apice rotundata, petiolo subaequilonga. Pedunculus nudus, 2 ½-7 ½ dm altus, 2-3-chotomus, ramis 3-12 dm altis, racemos 2-13 cm longos racemose ferentibus. Involucra solitaria, brevipeduncula ta, turbinata, 5-lobata, 2-2 ½ mm alta, extus glabra, bracteolas multas linearioblanceolatas glandulosas continentia. Flores ca. 50-120, glabri, flavi, ca. 1.6 mm longi, segmentis oblongo-ovatis, interioribus angustioribus. Typus: Moran 10454 *(SD 54186). Ab aliis subgeneris* Ganysmae *magnitudine, inflorescentiae forma, copiaque florum involucri differt.*

Plant perennial, the caudex erect, simple or few branched above, 1-2 (-6) dm tall, 8-20 mm thick, covered above with old dried leaves, reddish brown below with persistent leaf bases, in sterile condition crowned with a rosette 2-3 ½ dm wide of ca. 30 close-set leaves. Leaves green, hirtellous, the trichomes colorless, 0.3-1.2 mm long; blades ovate, rounded at apex, mostly cordate at base, 5-11 ½ cm long, 3-9 cm wide, with 4-6 rather

Figure 1. Herbarium specimens of *Eriogonum angelense* (10421), from Isla Angel de la Guarda, showing sterile rosette and old floral stem, x 0.23.

prominent ascending veins on each side, the margins irregular and slightly crisped; petioles 4-11 cm long, 2-4 mm wide at apex, widening to 1-2 cm at the clasping base, distinctly ca.-9-nerved below. Flowering rosettes elongating to ½-1 dm, the floral stem terminal, erect, glabrous, 5-18 dm tall, once dichotomous or often also with a smaller third branch, the first internode 2 ½-7 ½ dm tall, 6-11 mm thick, each branch with its first internode ½-2 dm long and succeeding ones gradually shorter, each node with one branchlet, the branchlets ascending, mostly simple, 2-13 cm long (the upper shorter), with 4-12 nodes. Bracts in threes, shortly connate, oblong, subacute, pubescent especially ventrally and on margins, the lowest to 15 mm long, those of branchlets ca. 1 mm long. Involucres solitary, on peduncles 1-2 (-4) mm long, turbinate, glabrous without, pubescent within, 2-2 ½ mm high, 5-lobed for one-third their length with rounded lobes, containing numerous linear-oblanceolate glandular-puberulent bractlets 1 ½-2 mm long. Pedicels glabrous, 1 ½-2 ½ mm long. Flowers ca. 50-120, glabrous throughout. Perianth yellow, 1.6-1.7 mm long, the segments oblong-ovate, subtruncate, ca. 1.2 mm long, the outer 0.7-0.8 mm wide, the inner 0.5-0.6 mm wide. Filaments white, ca. 0.5 mm long; anthers light yellow, oblong, ca. 0.4 mm long. Ovary yellowish, ca. 0.5 mm long. Achenes not seen.

Type collection. — Occasional on south side of canyon at about 550 meters elevation, west slope of peak about 4 miles southeast of Puerto Refugio, Isla Angel de la Guarda, Baja California, Mexico (near 29°29 ½'N, 113°33'W), 22 March 1963, *Moran*

10454 — holotype: SD 54186; isotypes: DS, MEXU.

Distribution. — Known only from Isla Angel de la Guarda at 350 to 800 meters: rather scarce, in small colonies on ridges and canyonsides or less often in arroyo beds. Other collections: a dozen plants on N and W slopes on insular divide ca. 2 miles SE of Puerto Refugio, 500 m, *10421* (SD, UC, US); few in arroyo bed NW of Cerro Angel, 500 m, *12935* (SD); scarce on rocky slopes and in arroyo bed NW of Cerro Diablo, 350 m, *12456* (CAS, SD); half dozen plants on W slope SW of Cerro Diablo, 630 m, *12446* (SD).

Discussion. — At the type locality in March 1963, a few plants were preparing to flower, but only the very first flowers on one plant were open. At the other places where I saw the plant on that trip and in early March and late April 1966, none were flowering or preparing to flower. At each of the five places, however, old floral stems with involucres still remained.

Eriogonum angelense belongs to the subgenus *Ganysma*, most species of which are annuals and much smaller. It appears to differ from all previously known species in its generally larger size, its open inflorescence whose two or three main branches are essentially racemes of racemes, and its more numerous flowers per involucre. It is perhaps most closely related to *E. inflatum* Torr. & Frem., native from Utah to central Baja California; but it differs further in its almost palmlike habit, its somewhat larger and non-glandular involucres on shorter peduncles, and its smaller and glabrous perianth. *Eriogonum inflatum* var. *deflatum* I. M. Jtn. occurs on Isla Angel de la Guarda but apparently only near the shore and not with *E. angelense*.

Exploration of the peninsula of Baja California has reduced the list — never long — of plants known only from islands off its eastern shore, and these islands appear to have few endemics. Isla Angel de la Guarda, with four still listed, apparently has more than any other. Besides *Eriogonum angelense*, these are *Ferocactus johnstonianus* Britt. & Rose, *Penstemon clevelandii* ssp. *angelicus* (I. M. Jtn.) Keck, and *Hofmeisteria filifolia* I. M. Jtn. *Lyrocarpa linearifolia* Rollins is known only from Islas Angel de la Guarda and San Esteban.

Eriogonum zapatoense Moran, spec. nov. (Figs. 2, 8)

Frutex decumbens 1-4 (-7) dm altus, ad 2½ m latus, trunco basi ad 1 dm diam. Folia dense tomentosa, lamina crassa, oblonga, rotundata, 3-6 cm longa, 1-2½ cm lata, in petiolum 1-3 cm longum et 1½-2 mm latum gradatim angustata. Pedunculi 3-13 cm alti, inflorescentia cymosa, ½-2½ dm lata, axe 4-8-plo trifurcato. Involucra solitaria, subsessilia infernave pedunculata, campanulata, 2½-4 mm longa, 1½-3 mm lata, ca. 10-40-florata, extus tomentosa, intus subglabra, dentibus 5, deltoideis, obtusis, ½ mm longis. Pedicelli glabri. Perianthium flavum, 2½-3 mm longum, intus glabrum, extus basi hirtellum, segmentis obovatis, interioribus exteriora excedentibus. Typus: Moran 15114 *(SD 67852). Ab* E. giganteo *atque* E. molli *habitu decumbenti staturaque minore, foliis crassioribus, pedicellis glabris, et perianthio flavo recedit.*

Shrub commonly prostrate, 1-4 or rarely 7 dm high, ½-2½ m wide, the herbage densely tomentose, the tomentum at first white and with a few spreading hairs to ½ mm long, at maturity gray and close. Trunk rarely 10 cm thick at base; branches commonly decumbent, to 2 m long and 3 cm thick, zigzag, often bare except at summit, reddish brown beneath shaggy brown outer bark. Branchlets 3-6 mm thick, covered and concealed by persistent sheathing-decurrent leafbases, each with 5-15 leaves in the upper 2-3 cm. Leaves tomentose, the blades thick, oblong, obtuse to mostly rounded at apex, 3-6 cm long, 1-2½ cm wide, conspicuously reticulate dorsally with projecting veins and venules, glabrate ventrally at post maturity and exposing a surface which in the dried leaf is often orange-brown to dark red,

Figure 2. Type specimen of *Eriogonum zapatoense* (15114), from Islote Zapato, Isla Guadalupe, x 0.25.

gradually narrowed below into a petiole ca. 1-3 cm long and 1 ½-2 mm wide, the base an obconic sheath oblique at top. Floral stem plus inflorescence ½-2 ½ dm high, the peduncle of one internode 3-13 cm tall, 2-3 mm thick, terminal, growth later continuing sympodially. Inflorescence cymose, ½-2 ½ dm wide, imperfectly 4-8 times trichotomous, some lower trichotomies about equal but the upper with branches unequal or some suppressed, each fork with a terminal involucre, or the lower sometimes with a terminal axis bearing 1-2 whorls of branches and a terminal involucre. Bracts connate at base, the lowest unequal, oblong to spatulate, 5-25 mm long, 1 ½-6 mm wide, the uppermost equal, triangular-ovate, ca. 1 ½ mm long. Involucres solitary, sessile or the lower on peduncles to 5 mm long, campanulate, 2 ½-4 mm long, 1 ½-3 mm wide, glabrous within, tomentose without, with 5 triangular-obtuse teeth ca. ½ mm long, each involucre with ca. 10-40 flowers. Pedicels 2-3 mm long, glabrous. Perianth yellow, 2 ½-3 mm long, glabrous within, densely hirtellous without at base, the lobes obovate, rounded at apex, glabrous on the broad thin margins, the outer 1.2-1.5 mm long, 1.1-1.3 mm wide, the inner 1.5-1.8 mm long, 0.9-1.0 mm wide. Filaments inserted at top of tube, ca. 1.3-2.0 mm long, bearded at base; anthers 0.5-0.6 mm long. Achenes brown ca. 2.2 mm long and 0.8 mm thick; styles ca. 1.2 mm long; seed dark brown, ca. 1.7 mm long. Gametic chromosome number: $n = 20$.

Type collection. — Rather common on south and southwest inner slopes of the crater at 50 meters elevation, Islote Zapato (Outer Islet), 2 miles south of Isla Guadalupe, Baja California, Mexico (near 28°51'N, 118°17'W), 21 June 1968, *Moran 15114*—holotype: SD 67852; isotypes: K, MEXU, UC, US, etc.

Distribution. — Known only from Islote Zapato at elevations of 50 to 200 meters. Other collections: *Remple* in July 1937 (DS); *Moran 2927*, March 1948 (CAS, DS, SD); *Kuijt, Miller, & Lindsay 1042*, June 1955 (SD, UC); *Lindsay 2623*, June 1955 (DS).

Discussion. — Islote Zapato, two miles south of Isla Guadalupe, is little more than a seabound volcanic crater, whose inner slopes rise uniformly at about 45 degrees to meet the sheer outer seacliffs on three sides in a jagged knife-edge rim of greatly varying height: only to the east does this sharp rim give place to a narrow and almost flat hanging valley some 200 meters above the sea. *Eriogonum zapatoense* is common on the inner slopes of the crater, especially the south slope, and is occasional in the upper valley. In protected places, plants may grow more or less erect, but most are prostrate. Commonly the trunk or the few main branches run up slope, so that the plant is strongly asymmetrical. In many larger plants, the lower branches are dead and the foliage is clustered at the top. The March collection is sterile, the June collections are in flower, and the July collection is in bud. In June 1968 the inflorescences were generally smaller than the many remaining from the year before. Measurements cover the old as well as the new.

Eriogonum zapatoense is most similar to *E. molle* Greene, of Isla Cedros, Baja California, and to *E. giganteum* S. Wats., of Santa Catalina, San Clemente, and Santa Barbara Islands, California. In leaf shape it especially resembles *E. giganteum* ssp. *formosum* (K. Brandegee) Raven. Both *E. molle* and *E. giganteum* grow erect (and *E. giganteum* often much taller); and both have somewhat thinner leaves, commonly taller and stouter peduncles, and much larger and, especially in *E. molle*, denser inflorescences, with pubescent pedicels, and with white or pink flowers. My sterile collection of March 1948 was referred to *E. molle* (Moran, 1951).

From buds of the type collection, Dr. James L. Reveal reports a gametic chromosome number of $n = 20$.

Although the new species has been found only on Islote Zapato, for which it is named, it very likely occurs also on precipitous nearby Islote Toro (Inner Islet), where no botanist has been able to collect. It is one of five species of Islote Zapato never found on the main island of Guadalupe, the others being *Erysimum insulare* Greene, *Dudleya guadalupensis* Moran, *Rhus integrifolia* (Nutt.) Rothr., and *Lavatera lindsayi* Moran. *Coreopsis gigantea* (Kell.) Hall, a sixth species of Islote Zapato, was found on the main island in 1875 but has not been seen there since. Presumably all six species have been nearly or quite exterminated on the main island by the goats that have so drastically reduced the native vegetation.

Dudleya nubigena (Brandegee) Britton & Rose ssp. **cerralvensis** Moran, subsp. nov. (Fig. 3)

A subspecie typica foliis viridibus modiceve glaucis nec farinosis atque corollis flavis nec aurantiis usque rubris sat differt. Typus: Moran 3618 *(SD 69717).*

Caudex unbranched, erect, rarely 6 cm high, 1-2½ cm thick. Rosettes ½-1 (-2?) dm wide, of 15-30 leaves. Rosette leaves green or slightly glaucous, triangular-lanceolate to elliptic-oblong, acute, apiculate, 3-10 (-15) cm long, 12-20 (-35) mm wide, 2-4 (-5½) mm thick, flattish or slightly channeled ventrally, convex dorsally, the margins acute near base, obtuse above. Floral stems 1-3 dm tall, 2-4 (-5) mm thick, naked in lower 2½-11 cm, with 8-20 leaves above, the leaves ascending, narrowly triangular-ovate, obtusish, ½-1½ (-3) cm long. Inflorescence erect from the first, 5-8 cm wide, of 2 or 3 branches which bifurcate 0-2 times but usually once, the cincinni 2-5 cm long, each with 5-14 flowers. Pedicels erect (but often perpendicular to floral stem when that has declined), ca. 1 mm thick below and thicker upwards, the lowermost (6-) 10-15 mm long. Calyx 4-6 mm long, 4-6 (-8) mm wide, subtruncate to rounded below in anthesis, deeply divided, the disk sometimes narrower than

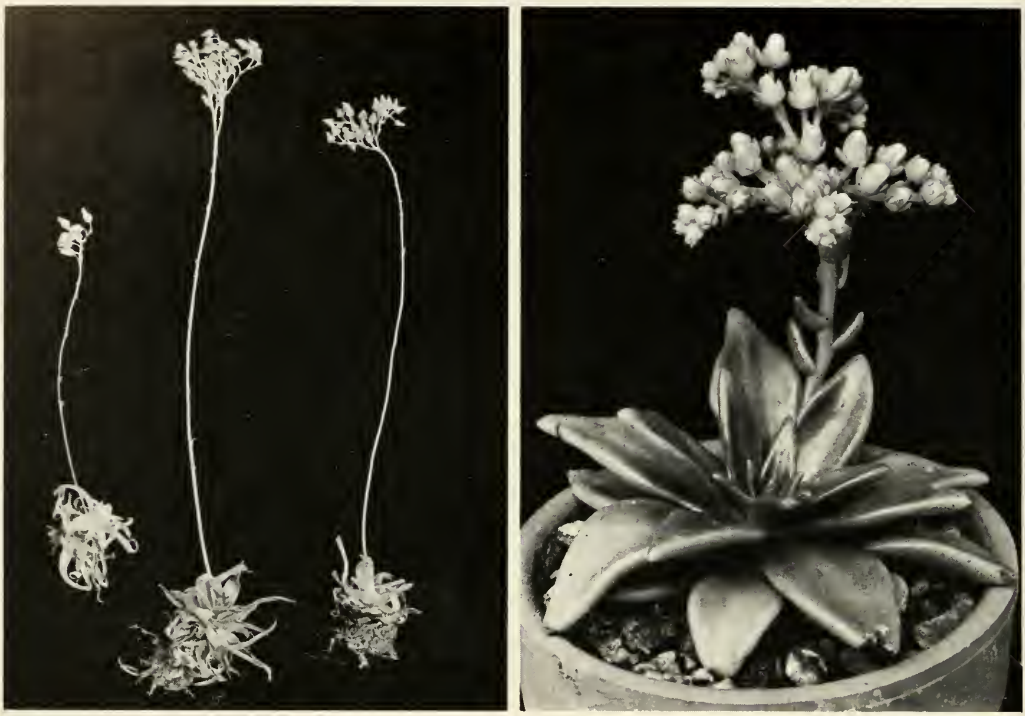

Figure 3. *Dudleya nubigena* ssp. *cerralvensis*. Left: freshly collected plants of the type collection (3618), 4 April 1952, x 0.2. Right: topotype (9542) flowering in San Diego 28 October 1962, x 0.6.

corolla, the segments erect or mostly ascending with tips ca. 1 mm from corolla, triangular-ovate, acute, 2½-5 mm long, 2½-3½ mm wide. Corolla clear yellow, pentagonal, 7½-10 mm long, 4-5 mm thick at base, 3-4 mm wide at apex, the tube 3-5½ mm long, the segments oblong, 1½-2 mm wide, rounded to broadly acute. Filaments light yellow, subulate, the epipetalous 6-7½ mm long, adnate 2-4 mm, the antesepalous 6½-8 mm long, adnate 2½-3½ mm; anthers light yellow, 1½-2 mm long. Nectar glands whitish, truncate, ca. ¼ mm high and 1 mm wide. Gynoecium 6-7½ mm high, ca. 3 mm thick, white below, yellowish above, the pistils erect, appressed, the styles ca. 1½ mm long. Ovules 50-80, ca. 0.5 x 0.2 mm. Gametic chromosome number: $n = 17$.

Type collection. — Locally common on north-facing granitic cliffs at 120 meters elevation, in the arroyo about 1 mile east of the abandoned Ruffo Ranch, southwest side of Isla Cerralvo, Territorio de Baja California Sur, Mexico (near 24°11′N, 109°51′W), 4 April 1952, *Moran 3618* — holotype: SD 69717; isotypes: BH, DS, UC, US. Some other duplicates may have been distributed by the Bailey Hortorium as *Dudleya* sp.

Distribution. — Known only from the type locality. Other collection: *9542*.

Discussion. — To judge from exploration in several parts of the island, this plant is not common, very likely being confined to relatively cool and shaded habitats, which are scarce. In April 1952, most plants were flowering (fig. 3, left); in April 1962, a drier season, I saw no plants flowering and only two with old floral stems apparently of that year.

Plants of the type collection flowered in the greenhouse at Ithaca in November 1952; some from the second collection flowered in San Diego in October 1962 and again, at what

seemed a more normal season, in the springs of 1964 and 1965. A plant of *Dudleya* brought into cultivation may look more different from its former self in the wild than plants of two different species, grown together, sometimes look from each other. The difference between wild and cultivated plants here was striking (fig. 3). The description is based on the freshly collected material and on the cultivated plants. The parenthetic extreme measurements are mostly from the cultivated plants.

Brandegee (1891) based *Cotyledon nubigena* on plants from "the summits of the Sierra de la Laguna"; but in the herbarium he later identified with it plants from San José del Cabo, near sea level. Rose (Britton & Rose, 1903) separated the lowland plants as *D. xantii*, the type specimen from Cabo San Lucas. It appears that his distinctions do not hold but that there may be other slight differences. Until further living material can be studied, however, I would include *D. xantii* in *D. n. nubigena*, to which it is at least very similar. This subspecies then is known from a dozen localities scattered through the Cape region of Baja California, from Isla Espíritu Santo to Cabo San Lucas and from sea level to 1800 meters. It is characterized by farinose leaves and orange to coral red corollas. *Dudleya n. cerralvensis*, in other ways very similar, differs in having green or slightly glaucous leaves and clear yellow corollas.

From cultivated plants of both collections, Dr. Charles H. Uhl reports a gametic chromosome number of $n = 17$ for *D. n. cerralvensis*. He has found the same number in one montane and several lowland collections of *D. n. nubigena*.

Rhus kearneyi Barkley (Fig. 4)

Rhus kearneyi has been known only from the Tinajas Altas Mountains of southwestern Arizona, where according to Kearney and Peebles (1951) it occurs at 1000 to 1500 feet elevation. It was at first confused with *R. integrifolia* (Nutt.) Rothr., of coastal southern California and northern Baja California. In typical *R. kearneyi*, the puberulence of twigs and bracts is sparser than in *R. integrifolia* and not closely appressed, the leaves are cordate or subcordate at the base and perhaps a little thinner, the cilia of the sepals are non-glandular, and the petals are non-ciliate. The twigs, bracts, and leaves, especially the under surfaces, bear short thick glands about 0.05 mm long, which turn orange-red and may persist as detached or easily detachable granules, resembling frass. The leaves, described as glabrous except for the glandular hairs, in fact are sparsely puberulent; and the tiny trichomes, if not always erect, at least are not closely appressed like the few sometimes found on the leaf blades of *R. integrifolia*.

My collections from Baja California include one from the east base of the Sierra San Pedro Mártir that seems referrable to typical *R. kearneyi* and several from the mountains farther south that seem to represent two new subspecies of *R. kearneyi*.

For reasons that he did not state, Barkley (1937) considered *R. kearneyi* most closely related to *R. standleyi* Barkley, of southeastern Mexico, and to *R. ovata* S. Wats., of Arizona, southern California, and northern and central Baja California. In Arizona, according to Kearney and Peebles, *R. ovata* occurs at 3000 to 5000 feet and thus much higher than *R. kearneyi*. Both the new subspecies of *R. kearneyi* occur at higher elevations than the typical subspecies, and both occur with *R. ovata*.

Rhus kearneyi ssp. *kearneyi*

Teledo Cañon, E side of Sierra San Pedro Mártir, 700 m, *7550* (DS, ICF, SD, UC). Collected in October, the specimen has only young inflorescences; but the petals in bud are seen to be non-ciliate. This was distributed as *R. integrifolia*.

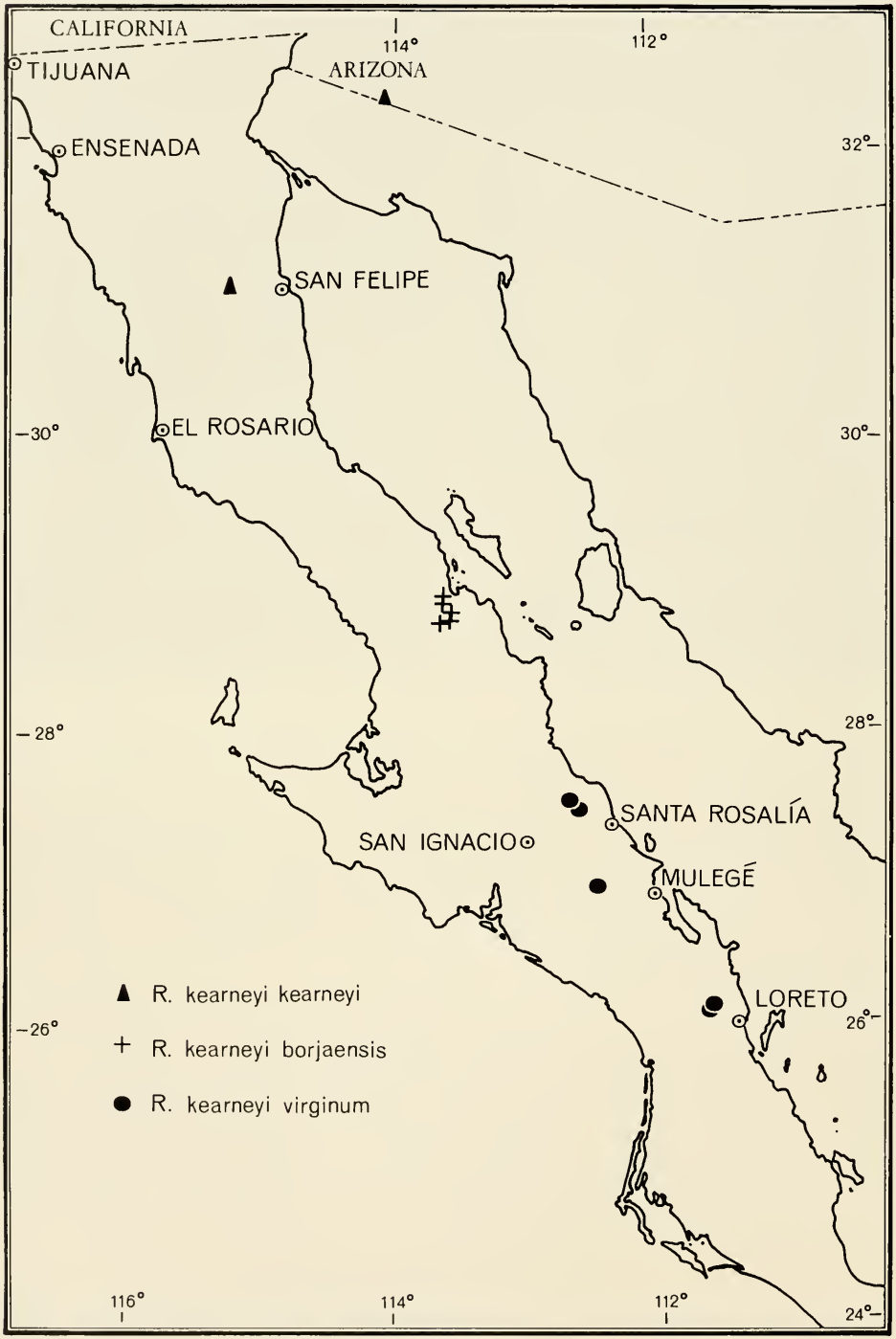

Figure 4. Distribution of *Rhus kearneyi*.

Rhus kearneyi ssp. **borjaensis** Moran, subsp. nov. (Fig. 5)

A subspecie typica ramulis dense foliisque sparsim hirtellis floribusque aliquantum majoribus differt. Typus: Moran 7999 *(SD 64051).*

Shrub ½-4 m high, the trunk to 1 dm thick. Herbage hirtellous with colorless trichomes to 0.5 mm or on twigs to 0.8 mm long and also bearing tiny sessile or granular glands that become orange-red. Branchlets 1 ½-2 ½ mm thick, reddish brown, glandular and densely hirtellous. Leaves simple, the petioles 3-6 mm long, 1-2 mm thick, glandular and hirtellous, the blades coriaceous, ovate to oblong-ovate, rounded to broadly acute at apex but commonly obtuse, cordate to broadly obtuse at base but commonly subcordate, entire or rarely glandular-serrulate at ends of main veins, 2 ½-4 ½ (-6 ½) cm long, 2-3 (-4 ½) cm wide, with thickened and somewhat revolute margins and with about 6-12 conspicuous pale ascending veins on each side of midrib, dark green and commonly drying brownish above, paler and often densely glandular beneath, sparsely hirtellous on both surfaces and more densely so on margins and midrib beneath. Inflorescence terminal, a compact panicle 1 ½-3 cm long, the branches spicate, densely hirtellous and glandular, flowering in March and April. Bracts persistent, ovate to rhombic-reniform, acute or obtuse, 2 ½-3 mm long, 2-3 ½ mm wide, densely pubescent on both surfaces. Bracteoles ovate, conduplicate, with broadly scarious margins, 2 ½-3 mm long, ciliate and somewhat pubescent. Sepals ovate, rounded at apex, cupped, 2 ½-3 mm long, 2-2 ½ mm wide, ciliate with non-glandular hairs, otherwise glabrous or sparingly pubescent. Petals white or pink, rhombic-obovate, 4-5 ½ mm long, 2-3 mm wide, slightly puberulent on midrib within, not ciliate. Filaments 1 ½-2 mm long, glabrous; anthers ca. 1.5 mm long and 1.2 mm wide. Ovary pubescent. Fruit 8-11 mm long and wide, 4-5 mm thick, red, densely glandular, densely pilose with trichomes to 1 mm long.

Figure 5. Left: type specimen of *Rhus kearneyi* ssp. *borjaensis* (7999), from the Sierra San Borja, x 0.23. Right: herbarium specimen of *Rhus kearneyi* ssp. *virginum* (11780), from the Sierra Santa Lucía, x 0.23. This collection has the longest leaves of any.

Type collection. — Occasional at about 1400 meters elevation near the summit of Cerro de la Mina de San Juan, Sierra San Borja, Baja California, Mexico (near 28°43'N, 113°38'W), 23 March 1960, *Moran 7999* — holotype: SD 64051; isotypes: K, MEXU, UC, US, etc.

Distribution. — Sierra San Borja, mostly at 1100 to 1650 meters elevation but in canyons occasionally down to 800 meters. Other collections: Arroyo de la Mina de Santa Marta, 1100 m (seen to 1450 m), *9764;* W rim of Tigre Cañon, 1200 m, *9927;* Cañon el Terminal, 800 m, *8398;* Cerro Quemazón, 1450 m, *8071;* Cerro la Sandía, 1650 m, *11527.*

Discussion. — This plant appears to differ from *R. k. kearneyi* chiefly in its denser and much longer pubescence and its slightly larger flowers.

Of the other five species included by Barkley (1937) in his section *Styphonia,* only *R. standleyi* Barkley, from southeast Mexico, and *R. muelleri* Standley & Barkley, from northeast Mexico, have spreading pubescence. *Rhus standleyi* differs from the present plant in its larger, subsessile, subrugose leaves, which are more closely covered with softer pubescence and have more strongly revolute margins. *Rhus muelleri* has broader and more rotund leaves, smaller sepals, and ciliate petals.

This subspecies seems well isolated from its closest relatives (fig. 4). At least in brief explorations I did not find it in the Sierra San Luis to the northwest or in the Sierra San Juan or the Sierra San Francisco to the southeast. It is named for the mountain range to which it is apparently confined. The name "Sierra San Borja" for this range is selected perhaps somewhat arbitrarily from those used on maps for various parts of the range, the other names being Sierra de Calmalli, Sierra San Lino, and Sierra San Juan; still other names not appearing on maps are used locally.

Rhus kearneyi ssp. **virginum** Moran, subsp. nov. (Fig. 5)

A subspecie typica foliis majoribus, acutis subacuminatisve differt. Typus: Moran 11664 *(SD 59520).*

Shrub or small tree 2-5 m high, the trunk to 2 dm thick, the bark rough, brown. Herbage puberulent with more or less spreading often curved colorless trichomes mostly less than 0.2 mm long and also bearing tiny sessile or granular glands that become orange-red. Branchlets 1-2 ½ mm thick, reddish brown, at first glandular and densely puberulent. Leaves simple, the petioles 3-14 mm long, 1-2 mm thick, the blades coriaceous, oblong-ovate, rounded to acuminate at apex but mostly acute, mostly rounded or subcordate at base, entire or glandular-serrulate with tooth at end of each main lateral vein, 3-6 (-8 ½) cm long, 1 ½-3 (-4) cm wide, with thickened and revolute margins and with 7-12 conspicuous pale ascending veins on each side of midrib, dark green above, paler and often densely glandular beneath, moderately puberulent to subglabrate on veins and sparsely puberulent to glabrate between. Inflorescence a terminal spike or compact panicle of spikes, flowering in September and October and rarely in February. Bracts persistent, rhombic-ovate, obtuse to subacute, cupped, strongly keeled, 2-3 mm long, 2 ½-3 mm wide, appressed pubescent within and without, pink. Sepals ovate, rounded at apex, cupped, 2-2 ½ mm long, 1 ½-2 mm wide, pink, ciliate with non-glandular hairs, otherwise glabrous. Petals white, narrowly obovate, rounded at apex, 3-3 ½ mm long, 1.2-1.8 mm wide, non-ciliate, puberulent at base within, otherwise glabrous. Filaments 1-1 ½ mm long; anthers 0.8-0.9 mm long, 0.7-0.8 mm wide. Ovary pubescent. Fruit not seen.

Type collection. — Occasional in arroyo at 1500 meters elevation, east slope of Volcan las Tres Vírgenes, Territorio de Baja California Sur, Mexico (near 27°28'N, 112°35'W), 11 February 1964, *Moran 11664* — holotype: SD 59520; isotypes: MEXU, UC, US.

Distribution. — Upper north slopes and downward along arroyos, Sierra de las Tres

Vírgenes, Sierra Santa Lucía, and Sierra de la Giganta, Baja California, at elevations of 1000 to 1750 meters. Other collections: N slope near the summit of Cerro Azufre, 1680 m, *11640;* arroyo on E slope of Cerro Barranco, Sierra Santa Lucía, 1400 m, *11780;* Cañada de Quemado, S side of Cerro Giganta, 1000 m, *Carter & Moran 5270* (SD, UC); N slope near summit, Cerro del Barreno, Sierra de la Giganta, 1350 m, *Carter & Moran 5358* (SD, UC).

Discussion. — The abundance and the associates of *R. k. virginum* vary from one area to another. It is fairly common at from 1200 to 1750 meters in the Sierra de las Tres Vírgenes, where associates include *Quercus ajoensis* C. H. Muller, *Bernardia incana* Morton, *Rhus laurina* Nutt., *Rhus ovata* S. Wats., *Ceanothus oliganthus* Nutt., *Rhamnus insula* Kell., and *Aralia scopulorum* Brandegee. In the Sierra Santa Lucía, where I saw it only locally, associates include *Prunus ilicifolia* cf. ssp. *lyonii* (Eastwd.) Raven, *Aralia scopulorum,* and *Randia megacarpa* Brandegee. In the Sierra de la Giganta, associates include *Celtis reticulata* Torr. and *Acacia goldmanii* (Britt. & Rose) Wiggins at the lower locality, where again I saw it only locally, and *Aralia scopulorum* at the upper, where I saw only one tree.

Unlike the other two subspecies, *R. k. virginum* appears to flower mainly in fall. In the Sierra de las Tres Vírgenes in February and the Sierra Santa Lucía in March, 1964, I found only one flowering plant, and that with very few flowers; the others lacked even young inflorescences. In the Sierra de la Giganta in September 1967, the plants were just beginning to flower.

Rhus k. virginum differs sharply from *R. k. borjaensis* and resembles *R. k. kearneyi* in the sparseness of its pubescence. It differs from both in its leaves, which are mostly acute or even acuminate and often somewhat larger. Also, the leaves usually dry light green, whereas in the other two they are darker and often brownish. In *R. k. virginum,* many though not all leaves have glandular teeth, the percentage varying in different collections. Such teeth are poorly developed in *R. k. kearneyi* and in most collections of *R. k. borjaensis,* though on one vigorous shoot of the latter (*9764* SD) the unusually large leaves have well developed teeth. Lack of material prevents a thoroughgoing comparison of floral details, but at least the anthers of *R. k. virginum* seem smaller than in the other two, and the sepals are glabrous.

Hedeoma martirense Moran, spec. nov. (Fig. 6)

Herba glandulosa hispidula perennis, rhizomata gracilia elongata emittens, caulibus gracilibus ½-1 ½ dm altis. Folia brevipetiolata, ovata ad elliptica, obtusa, 3-9 mm longa, 2-6 mm lata, supra glabra, margine revoluta. Cymulae paucae, uniflorae. Calyx subcylindricus, 7-9 mm longus, fauce dense annulatus, dentibus duobus inferioribus 2-3 mm longis, erectis, tribus superioribus tertia parte connatis, 1 ½-2 mm longis, aetate excurvatis. Corolla alba, 19-24 mm longa, tuba gracillima, cum fauce 17-20 mm longa. Typus: Moran 15069 *(SD 67322). Inter congeneros corollae tubo perlongo distinguitur, rhizomatibusque gracilibus elongatis insignis.* H. tenuifloro *affinis sed foliorum petiolis brevioribus laminisque supra glabris inflorescentiaque reducta praeterea differt.*

Low rhizomatous perennial herb with wiry stems, the herbage with glands secreting tiny yellow globules at the surface, hispidulous with often curved and often unequal tapering pluricellular white trichomes to 0.6 mm long, in sunny places stems and undersurfaces of leaves often purplish red. Rhizomes woody, to 5 mm thick, with dark brown bark; aerial shoots often branching below and often crowded, flexuous, ½-1 ½ dm tall, ½-¾ mm thick, glandular and hispidulous with more or less decurved trichomes, quadrangular, the two faces below each leaf pair slightly convex, the other two channeled, the upper internodes ca. 3-5 mm long; young rhizomes like the aerial shoots but to 3 dm long, stramineous, often scarcely or not at all hispidulous, glandular-puberulent or (only after the first season?) glabrous, the

Figure 6. Pressed specimen of *Hedeoma martirense* (15275), from the high Sierra San Pedro Mártir, x 0.75.

internodes ½-1 ½ cm long, the scale leaves sessile, ovate, blunt, ca. 1 mm long. Leaves petiolate, the blade coriaceous, from ovate in the lower to elliptic in the upper, obtuse to rounded at apex, cuneate to rounded at base, entire, 3-5 (-9) mm long, 2-3 (-6) mm wide, dorsally glandular-pitted or subrugose and sparsely antrorse-hispidulous, ventrally eglandular and glabrous or scabrous with a few stout conic trichomes ca. 0.05 mm long, the margins revolute, the midrib slightly projecting dorsally, the 2-3 pairs of ascending lateral veins obscure, the petiole 1-2 mm long, channeled ventrally. Flowers May to August, the cymules at 1-4 upper nodes, one-flowered, the peduncle ½-2 mm long, with an apical pair of linear bracts 1-2 mm long, the pedicel 2-3 mm long, spreading. Calyx 7-9 mm long, commonly purplish, the tube subcylindric but slightly ampliate upward and in fruit slightly swollen in lower third, 4 ½-6 ½ mm long, ca. 1 mm wide (pressed to 1 ½ mm wide), with 13 prominent ribs, sparsely hispidulous on ribs towards the base with trichomes ca. 0.3 mm long and glandular puberulent, glabrous within except for a dense ring at the throat of upwardly appressed and partially exserted stiff white trichomes ca. 0.6 mm long, the teeth triangular-lanceolate, sparsely hispidulous-ciliate, the lower two erect, 2-3 mm long, subulate above, the upper three connate one-third, 1 ½-2 mm long, slender-acute, in age somewhat outcurved. Corolla white or slightly tinged with pink, 19-24 mm long, glabrous in lower 3-4 mm, hirtellous above with trichomes ca. 0.2 mm long, the tube 14-15 mm long, ca. ½ mm wide below and scarcely wider above, sparsely hirtellous within over more or less of upper half, the throat 3-5 mm long, 1 ½-2 mm wide above, glabrous within, the upper lip 2-3 mm long, 1 ½-2 mm wide, emarginate to a depth of 0.2-0.6 mm, minutely papillose-puberulent within, the lower lip 3-4 ½ mm long, 3-4 mm wide (spread out), minutely papillose-puberulent, the middle lobe 1 ½-2 mm long, 1 ¼ mm wide, slightly emarginate, upcurved, the lateral lobes ca. 1 mm long and wide. Filaments ca. 3 mm long, exserted ca. 1 mm, glabrous; anthers divaricate, purple, ca. ½ mm long; vestiges of other stamens ca. 0.3 mm long. Style 18-23 mm long, glabrous, the posterior lobe about half the anterior or subobsolete. Nutlets reddish brown, elliptic, 1.4-1.6 mm long, 0.6-0.7 mm wide, 0.5 mm thick.

Type collection. — Rock crevices on east slope at 2700 meters elevation, east rim of the Sierra San Pedro Mártir north of Yerba Buena, Baja California, Mexico (near 31°01'N, 115°26'W), 1 June 1968, *Moran 15069* — holotype: SD 67322; isotypes: K, MEXU, UC, US, etc.

Distribution. — Abundant locally on north and east slopes at 2300 to 2800 meters elevation, especially in shade but also in the open, north central Sierra San Pedro Mártir. Other collections: E slope at head of Arroyo Copal, 2300 m, *15463;* N slope of Cerro "2828", 2575 m, *15446;* E slope of Cerro "2828", 2800 m,*15266*, 2750 m, *15275*.

Discussion. — This plant grows most luxuriantly on north slopes in open pine-fir forest, where it may spread among rocks to form a rather uniform though scarcely dense groundcover. On the steep eastern escarpment of the Sierra, it grows also on drier and more open slopes and, at its lower limit, into the border of the montane chaparral.

Hedeoma martirense is noteworthy for its slender rhizomes and somewhat matting habit. The long slender corolla is also remarkable, the tube plus the throat being 17 to 20 mm long and the tube proper less than 1 mm wide. To judge from the descriptions of Epling and Stewart (1939), the length is approached only in *H. costatum* A. Gray, where it is 6 to 18 but commonly 11 to 15 mm, and in *H. quercetorum* Epling, where it is 14 to 16 mm (less in a recent collection, annotated by Robert S. Irving). The variable *H. costatum*, ranging from Arizona to Texas and northern Mexico, is a somewhat coarser plant, with longer internodes and larger leaves; the leaves are serrate and more acute, pubescent on both sides, and thinner, with more prominent veins; and each cymule has three to several flowers. In *H. quercetorum*, of northeastern Mexico, the stems are less branching and less flexuous, the pubescence of stems and leaves is shorter and finer, each cymule has one to several flowers, the calyx tube is curved, and the upper leaves are longer and linear-elliptic, with prominent lateral veins more or less parallel to the midrib. However, the lower leaves are similar to those of *H. martirense*, being ovate with revolute margins, rather thick with the veins often obscure, purplish red beneath, and nearly as small.

Epling and Stewart divided the genus into twelve unnamed but numbered sections. Though not exactly fitting their sectional definition, *H. martirense* seems closest to section 9, in which they placed *H. costatum*, *H. quercetorum*, and five other species. It is perhaps most closely related to the little-known *H. tenuiflorum* Brandegee, of the Sierra San Borja, some 175 miles to the south-southeast in Baja California. That is a bushier plant without rhizomes, with similar but more elliptic and sometimes toothed leaves hispidulous on both sides and with longer petioles; the cymules commonly are more numerous and commonly have three to several flowers each; and the corolla tube is about 13 mm long. That species occurs in a more arid habitat, not only farther south but also at lower elevations — at about 1475 meters and probably well below; associates include *Quercus turbinella* Greene, *Anemone tuberosa* Rydb., *Ribes quercetorum* Greene, *Vauquelinia californica* (Torr.) Sarg., *Dodonaea viscosa* Jacq., *Rhamnus insula* Kell., *Idria columnaris* Kell., and *Echinocereus engelmannii* (Parry) Rümpl.

Monardella lagunensis M. E. Jones ssp. **mediopeninsularis** Moran, subsp. nov.
(Figs. 7, 12)

Suffrutex fragrans glandulosus hirtellus, trichomatibus plerumque 0.1-0.2 mm longis, caulibus gracilibus 3-8 dm altis e basi 1-4 cm crassa. Folia triangulo-ovata, apice rotundata, 8-20 mm longa, 4-12 mm lata, petiolis 1-8 mm longis. Capitula ½-2½ cm lata ca. 20-125-flora, bracteis adpressis submembranaceis, exterioribus ovatis 5-8 mm longis, interioribus angustioribus. Calyx 6-7½ mm longus, 13-nervatus. Corolla 9-10½ mm longa. Typus: Moran 12147 *(SD 70685). A subspecie typica foliis parvioribus capitulis parvioribus ex*

Figure 7. Pressed specimen of *Monardella lagunensis* ssp. *mediopeninsularis*, from Cerro Potrero, x 0.5; part of the type collection (12147).

floribus paucioribus parvioribusque constantibus trichomatibusque brevioribus differt.

Fragrant subshrub 3-8 dm high, with many slender branches from a woody base 1-2 or rarely 4 cm thick. Herbage hirtellous with slightly curved pluricellular white trichomes 0.1-0.2 mm long or on vigorous shoots rarely *(10460)* to 0.5 mm long; also glandular, the surface shallowly pitted, each pit supporting a viscid yellowish globule ca. 0.05-0.1 mm thick. Branches often taking two seasons to flower, often with lateral branches below by flowering time, at first ca. 1 mm thick and closely hirtellous with slightly deflexed trichomes, dying back about to middle after flowering, becoming woody below but rarely over 4 mm thick except at very base, the bark tan in new fissures, becoming gray, the lower internodes ca. ½-1 ½ cm long, the upper longer, sometimes to 6 cm. Leaves petiolate, the blade triangular-ovate, rounded at apex, rounded to cuneate or commonly somewhat attenuate at base, with 2-3 weak crenations on each side or commonly entire, 7-20 mm long, 4-10 (-12) mm wide, equally hirtellous above and beneath but more conspicuously pitted beneath, the midvein prominent beneath, with 2-4 arching laterals on each side, the margins somewhat revolute, the petiole 1-3 (-8) mm long. Heads in May and June or a few as early as February, 1 ½-2 (½-

2 ½) cm wide, each with ca. 20-125 flowers, the bracts appressed, thinner than leaves and somewhat membranous, with prominent veins, often purplish, glabrous ventrally except toward apex, hirtellous dorsally and closely ciliate with longer trichomes, the outer ovate, acute to narrowly rounded, 5-8 mm long, 2-5 mm wide, with lateral veins arching and nearly parallel to midrib, the inner oblanceolate or narrower, acute. Calyx 6-7 ½ mm long, ca. 13-nerved, often purplish, hirtellous, the teeth erect, narrow-triangular, acute, nearly equal, 1 ¼-2 mm long, hirtellous within. Corolla white or slightly tinged with pink or lavender, 9-10 ½ mm long, the tube 6-7 mm long, gradually ampliate above, sparsely retrorsely hispidulous inside and out in upper half, the lobes oblong, rounded at apex, 2 ½-3 ½ mm long, 0.6-0.9 mm wide, sparsely hispidulous outside and glandular, with 3-7 sessile yellow globules ca. 0.1 mm thick crowded at tip, the upper two lobes united ca. ⅓-½, the lower three free. Filaments glabrous or with a few hairs at base, apparently elongating markedly during anthesis, the lower two inserted near sinuses, 3-5 mm long, the others inserted on base of upper lip, 2-3 ½ mm long; anther sacs divergent. Style glabrous, apparently elongating markedly during anthesis, becoming ca. 11 mm long, the stigma lobes ca. 0.3 mm long. Nutlets oblong, tan, smooth, 1.1-1.4 mm long, 0.6-0.8 mm wide.

Type collection. — Common among rocks, mostly on the north slope, summit of Cerro Potrero at 1400 meters elevation, Baja California, Mexico (near 29°49′N, 114°37′W), 30 May 1965, *Moran 12147*— holotype: SD 70685; isotypes: K, MEXU, UC, US, etc.

Distribution. — Known only from four peaks in central Baja California (fig. 12), at 750 to 1900 meters elevation. Other collections: N slope of Cerro Santa María, 1200 m, *11481* [sterile]; steep north-flowing arroyo on W side of peak ca. 4 miles SE of Puerto Refugio, Isla Angel de la Guarda, 900 m, *10460;* arroyo on E slope of Volcan las Tres Vírgenes, 1500 m [seen to 1900 m], *11666.*

Discussion. — The four known localities for this plant are scattered over some 200 miles (fig. 12). I have partially explored various peaks in the intervening Sierras San Luis, San Borja, San Juan, and San Francisco, without finding it. At the three northern localities, it was found mainly or entirely on north slopes and at the southernmost, so far as I remember, mainly so.

The new subspecies differs from *M. l. lagunensis* in its smaller leaves, its smaller heads with fewer and smaller flowers, and its shorter trichomes. The leaf blades in *M. l. lagunensis* are mostly 12 to 22 mm long and in *M. l. mediopeninsularis* mostly 8 to 15. However, in the northernmost (and type) collection, with abundant material found in better condition than the other collections, a few vigorous shoots have leaf blades to 20 mm long. The heads in *M. l. lagunensis* are mostly 2 to 3 ½ but sometimes as little as 1 ½ cm wide, in *M. l. mediopeninsularis* mostly 1 ½ to 2 but occasionally 2 ½ cm wide. The flowers of *M. l. mediopeninsularis* are similar to those of *M. l. lagunensis* but proportionally smaller, the calyx, for example, 6 to 7 ½ mm long as compared to 7 to 9 and the corolla 9 to 10 ½ mm long as compared to 11 to 12. In *M. l. lagunensis* the longer trichomes are about 0.5 to 0.6 mm long. In the southernmost collection of *M. l. mediopeninsularis* the longer trichomes are about 0.2 mm long; in the next most southern collection (actually from closer to the two northern localities) they are mostly about 0.2 mm but on one vigorous shoot 0.4 to 0.5 mm long; and in the two northern collections they are about 0.1 mm long. *Monardella linoides* A. Gray, of the Sierra San Pedro Mártir and northward, might be said to continue the trend in decreasing trichome length, having one-celled trichomes about 0.05 mm long; but that is a distinct species, with narrower leaves and longer corollas.

Smaller-leaved specimens of *M. l. mediopeninsularis* resemble *M. thymifolia* Greene, of Isla Cedros; but in that species the leaf blades are 5 to 10 mm long, the trichomes about 0.5 mm long, and the corollas 12 to 14 mm long, with the tube conspicuously exserted from the

Figure 8. Old plant of *Eriogonum zapatoense*, on Islote Zapato, Isla Guadalupe, showing crooked decumbent stem; part of the type collection (15114), 21 June 1968.

Figure 9. Herbaceous young plant of *Castilleja fruticosa* (6687), south end of Isla Guadalupe, 27 March 1958. Note thickness of leaves.

Figure 10. Flowering plant of *Heterotheca martirensis*, in the high Sierra San Pedro Mártir, 14 September 1968; part of the type collection (15612).

Figure 11. Flowering plant of *Stephanomeria monocephala*, in the high Sierra San Pedro Mártir, 5 July 1968; part of the type collection (15261).

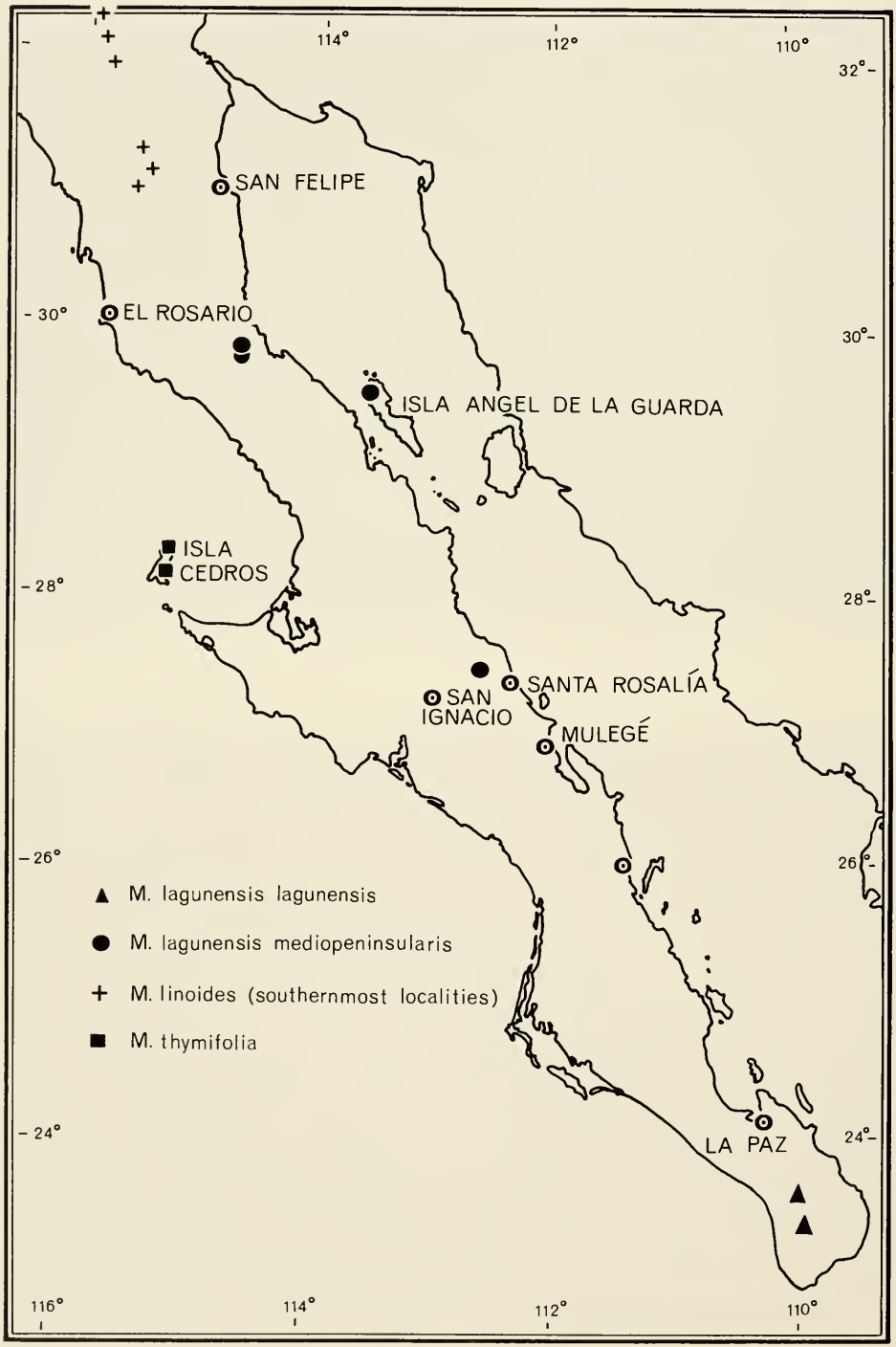

Figure 12. Distribution of *Monardella lagunensis* and related species.

calyx. In his monograph, Epling (1925) based his description of *M. thymifolia* on about eight sheets of four collections, mostly past flower. He commented that the few available specimens were uniform in appearance, and his description bespeaks uniformity (e.g. leaves 5-8 mm long, calyx 6-7 mm long, corolla 12-13 mm long). It is noteworthy that my two collections of the species, from stations well separated on Isla Cedros, agree rather closely with his description and so reinforce the appearance of uniformity. *Monardella lagunensis* seems quite distinct from *M. thymifolia.*

Castilleja fruticosa Moran, spec. nov. (Figs. 9, 13)

Planta perennis, glanduloso-puberula villosaque, 2-9 dm alta, caule lignoso, ad 4 cm diametro. Folia crassa, linearia, ½-6 cm longa, 1-5 mm lata, basi articulata, integra supremave trilobata. Spica densa, 2½-7 cm longa, 5-20-flora, miniata, bracteis 1-2½ cm longis, plerumque trilobatis. Calyx 14-21 mm longus, antice posticeque 8½-14 mm latere 0-4½ mm fissus, lobis subaequalibus, triangularibus usque oblongis. Corolla 17-26 mm longa, infra glabra, galea 9-13 mm longa, postice lutea dense glanduloso-puberula, marginibus hyalinis, anguste revolutis, labio inferiore 2-3 mm longo. Capsula 7-10 mm longa, lignosa, antice concava usque transverse sulcata, sero dehiscens. Typus: Moran 15733 *(SD 70310). Species caulibus duro-lignosis atque capsulis lignosis subindehiscentibus insignita. A* C. guadalupensi *pubescentiae forma (illa tomentosa) et calyce antice posticeque aequaliter fisso valde differt.*

Woody perennial 2-5 or rarely 9 dm high and to 5 dm or more wide, but flowering while still herbaceous, perhaps in first season. Herbage glandular-puberulent, with trichomes mostly 0.05-0.3 mm long, and in part also villous, the longer trichomes pluricellular, tapering, unbranched, 1-2 mm long. Stem at first straight and erect, with several regular horizontal to ascending branches, with sympodial growth after flowering becoming crooked and irregularly close-branching, to 2 or rarely 4 cm thick, the wood hard and brittle, the bark mostly dark brown, the few longitudinal fissures lighter brown; branches villous. Leaves light green, rather succulent and the smaller ones subterete, linear-oblong to linear-oblanceolate, rounded to broadly acute, entire or the uppermost 3-lobed, articulated to a decurrent base and readily detached, ½-1½ mm wide at constriction, glandular-puberulent and the upper commonly somewhat villous near base, commonly ½-2½ cm long, 1½-3 mm wide, and 1-2 mm thick, the upper ones in favorable seasons sometimes larger, even 6 cm long and 5 mm wide, relatively thinner, and less clearly articulated at base; midvein translucent, often impressed ventrally and in thicker leaves sometimes also dorsally, the lateral veins not evident. Inflorescence terminal, a compact spike 2½-7 cm long, of 5-20 flowers, often densely villous, the bracts and calyx tipped with Indian orange, the pigment especially concentrated in the glandular trichomes; dead axis commonly persisting one or more seasons. Bracts 1-2½ cm long, ½-2 cm wide, generally glandular-puberulent and mostly somewhat villous, especially on lower margins and midribs, the lower ones sometimes entire and the uppermost sometimes 5-lobed but most 3-lobed, the lobes oblong to mostly spatulate, obtuse to rounded, the midlobe 3-9 mm wide, the lateral lobes ascending from near the middle, 1-3½ mm wide. Calyx glandular-puberulent, villous below, especially on nerves, 14-21 mm long, about equally cleft before and behind for 8½-12 mm, the segments 2½-4 mm wide, entire or mostly cleft 1-4½ mm into subequal triangular to oblong acutish lobes 1-2 mm wide, the anterior often slightly wider than posterior. Corolla 17-26 mm long, with 19 veins, glabrous below, sparsely glandular-puberulent towards middle; lower lip yellowish green, glandular-puberulent especially above, projecting abruptly anteriorly for 1½-2 mm and cupped upward for 2-3 mm, the apex 9-14 mm above corolla base, the lobes ca. 1 mm long and wide, acutish to rounded, the palate of two finlike yellowish

glandular evaginations ca. 1-1 ½ mm long and ¾-1 mm high, each continuing upward as a low ridge for ca. 1-1 ½ mm to the sinus; galea 9-13 mm long, when flattened 4 ½-8 mm wide at base and ca. 3 mm wide just below apex, exserted ca. 2-6 mm beyond calyx, slightly curved anteriorly, densely glandular-puberulent dorsally above, dorsally yellowish green becoming yellow and sometimes later reddish, the hyaline margins ca. 1 mm wide above and wider below, sharply differentiated above from the herbaceous center, closely rolled outward below, the apex rounded. Stamens glabrous, the anterior filaments 7 ½-16 mm long, inserted 7 ½-9 mm above corolla base, the posterior 7-15 mm long, inserted 6 ½-8 mm above corolla base; anthers 2-2 ½ mm long, ca. ¼ mm wide. Ovary glabrous, greenish, laterally compressed above and obliquely obovate, 2 ½-4 mm long, 1-1 ½ mm wide, 1 ½-2 mm thick, the rounded apex sometimes extending beyond the style base; style a continuation of the posterior keel, yellowish green, 17-25 mm long, exserted before anthesis and finally by 2-4 mm. Capsule woody, blackish, triangular-ovoid, tapering in width apically to a sharp sagittal keel continuous with low anterior and posterior keels, 7-10 mm long, 3 ½-5 mm wide and thick, the anterior surface concave to transversely and sometimes tightly infolded, with a furrow to 2 mm deep; persisting on dead inflorescence for one or more seasons mostly unopened even though containing well-formed seeds, the two cells occasionally separating slightly at apex and less often also the valves splitting lengthwise in upper fourth. Seeds dark brown, irregularly obovoid, 1.6-2.1 mm long and 1.0-1.2 mm wide including loose alveolate coat.

Type collection. — Occasional on barren mesa at 100 meters elevation, just east of the weather station, southwest corner of Isla Guadalupe, Baja California, Mexico (near 28°53'N, 118°17 ¼'W), 23 February 1969, *Moran 15733* — holotype: SD 70310; isotypes: K, MEXU, UC, US, etc.

Figure 13. Pressed specimen of *Castilleja fruticosa* (7850), from the south end of Isla Guadalupe, showing flowers and persistent capsules, x 0.75.

Distribution. — Local at the south end of Isla Guadalupe and on offlying Islote Zapato (Outer Islet). Other collections: S inner slope of red crater 1 mile N of Morro Sur, 320 m, *6479;* 1 ½ miles NE of weather station, 220 m, *7850;* type locality, *6142, 6687, 12068, 13768, Wiggins & Ernst 136* (DS, US), *Carlquist 482* (RSA), *Copp 175* (DS); Islote Zapato, *Remple* in 1937 (DS), *Moran 2922* (CAS, DS, SD), *5657, 15113, Lindsay 1805* (DS, SD), *2624* (SD), in 1956 (SD), *Kuijt, Miller, & Lindsay 1050* (UC).

Discussion. — This plant occurs on a barren volcanic mesa and in two craters near the south end of Isla Guadalupe, in an area of very low rainfall but of frequent fogs. Though fairly common locally, it is thus very narrowly restricted. In 1948 I collected it on Islote Zapato but failed to find it on the main island, even though I collected at the very spot on the mesa where its bright flowers are now conspicuous. In 1957 I did find it on the mesa but saw only herbaceous plants looking almost like annuals. In 1960 it was a little more widespread there than I have seen it before or since, and in 1967 and later, some plants were small shrubs with woody stems to 2 cm thick. These facts suggest that in 1957 *C. fruticosa* might recently have colonized the main island from one of the nearby islets. Although the goats that have ravaged the northern part of the island may never have been common at the desertic south end, comparison of the vegetation with that of the islets suggests that enough goats came to keep certain plants near the point of extinction. Since the establishment of the weather station in 1946, however, goats have visited the south end at their peril, and the vegetation thus has had some protection.

Among associated species, several are similarly restricted on the island. I have seen *Euphorbia pondii* Millsp. only in an even smaller colony in the same part of the mesa. The endemic *Hemizonia palmeri* Rose is confined to a slightly larger area within about one mile of the south end. The endemic *H. greeneana* Rose ssp. *greeneana,* one of the most abundant and conspicuous plants at the south end, extends north only about two miles; it occurs also on Islote Zapato and Islote Negro. The endemic *Baeriopsis guadalupensis* J. T. Howell has been found only at the south end and on Islote Zapato and Islote Negro, though possibly it occurs farther north on unexplored seacliffs. *Hutchinsia procumbens* (L.) Desv. has been found only at the south end and on Islote Zapato. *Euphorbia misera* Benth., common on Islote Zapato and very rare on cliffs in the northern canyons, also occurs rarely on the south-end mesa. *Lomatium insulare* (Eastw.) Munz likewise occurs on Islote Zapato and on the south-end mesa, and it occurs also on one cliff high at the north end of the island. These last two species, like *Castilleja fruticosa,* may possibly be recent colonists at the south end. A recent unsuccessful colonist there was *Lavatera occidentalis* S. Wats., which is common on Islote Zapato and is represented by two or three old shrubs on northern cliffs: a single robust seedling 1 meter high grew in an arroyo 3 miles from the south end in 1965, when the goat population was at a low ebb, but has since disappeared.

Castilleja fruticosa, though still herbaceous at first flowering, is remarkable for the thick and hard woody stems of older plants. Apparently it is one of the woodiest of the genus. The foliage leaves are quite thick and somewhat succulent, as is often true of maritime plants. The capsules are unusually hard and woody and are distinguished by a depression on the under side, which sometimes becomes a deep transverse groove, as if the capsule were caved in. On most specimens, capsules from previous years persist on dead inflorescence axes, mostly still unopened and still holding seeds. Seeds from closed capsules have proven viable.

Castilleja fruticosa falls in the section *Perichroma* Pennell (Pennell, 1935). The only recent treatment of any major part of the genus is that of Pennell (1951) for the 71 species of Washington, Oregon, and California — out of some 200 species all told. The genus is poorly represented in Baja California, with apparently only four species, including two Guadalupe

Island endemics, that do not occur also in Alta California; and the flora of Guadalupe Island is more closely related to that of Alta California than to that of peninsular Baja California. Nevertheless, the new species does not fit clearly into any of the 19 groups (apparently subsections) informally proposed by Pennell (1951). However, it is close to groups x through xvi, perhaps differing from all their species in having woodier stems and woodier and often tardily dehiscent transversely grooved capsules but otherwise differing from each mainly in the kind and distribution of pubescence.

This plant was first reported (Moran, 1951), and has since been identified in herbaria, as *C. guadalupensis* Brandegee, another Guadalupe Island endemic with hard woody stems. That plant occurs (or occurred) in a different habitat, on the higher and much moister northern part of the island. It has not been collected since 1898 and evidently is now very rare if not extinct. Herbarium material is meager.

The little-known *C. guadalupensis* is a woody plant 3 to 6 dm tall, whose stems, leaves, and calyx are at first densely and closely tomentose with dendritic hairs. The leaves are narrowly spatulate, rather thin, to 6 cm long and 1 cm wide. Brandegee (1903) described the calyx as "cleft equally before and behind about one-half its length", as in the presumably related *C. foliolosa* H. & A.; but in three fairly well exposed flowers of one Palmer specimen (GH) it clearly is cut about twice as deeply behind as before — as in no other species known to me. The corolla is slightly longer to slightly shorter than the calyx; the galea, about equalling the tube, is densely puberulent the length of the back with pluricellular but unbranched non-glandular trichomes about 0.1 to 0.2 mm long. The style is exserted about 3 to 5 ½ mm. Clearly this is a very distinct species.

Castilleja fruticosa thus is amply different from *C. guadalupensis*, notably in the cutting of the calyx but also in the type of pubescence and in the form and size of the leaves.

Hemizonia greeneana Rose ssp. **peninsularis** Moran, subsp. nov. (Fig. 14)

Frutex glanduloso-viscidus prostratus vel erectus tum quoque ad 12 dm altus ramis virgatis. Folia inferiora subremota filiformia usque linearo-oblanceolata integra vel 2-8-dentata hirsuta 2-7 cm longa, superiora conferta linearia plerumque hirtella ½-1 cm longa ½-1 mm lata. Capitula thyrsoidea plerumque 8-radiata, primis usque 14-radiatis. Involucra 4-7 mm alta, 4-6 mm diametro, bracteis receptaculi 8-13 uniseriatis ad medium infirme connatis. Disci flores 8-21 steriles, pappo 1.9-3.3 mm longo, paleis 9-15. Typus: Moran 13437 *(SD 70684). A ssp.* greeneana *ramis plantarum altiorum virgatis, foliis infimis saepe longioribus remotioreque dentatis, superis plerumque hirtellis, pappo plerumque longiore paleisque numerosioribus differt.*

Prostrate or erect shrub 2-8 or reportedly to 12 dm high and ½-1 ½ m or more wide, with herbage glandular-viscid throughout. Stems to 4 cm thick at base, the bark gray-brown. Branches commonly virgate, hirsute with multicellular white trichomes to 3 mm long, rather sparsely leafy below, the internodes ca. ½-1 ½ cm long, the axils sometimes later floccose, only the lowermost leaves opposite, the middle axils often with fascicled leaves, the upper mostly with leafy branchlets; ultimate branchlets or peduncles ca. ½ mm thick, hirtellous, closely leafy, with shorter internodes and fascicled leaves. Lower leaves filiform to linear-oblanceolate, acute, 2-7 cm long, ½-5 mm wide, with subrevolute or thickened margins, entire or often with 2-8 ascending acute teeth or lobes to 5 mm long and 1 ½ mm wide, hirsute with trichomes to 1 mm long, somewhat succulent and to 2 mm thick in plants nearest the shore; upper leaves gradually smaller, entire, those of the peduncles linear-oblong, obtuse, ca. ½-1 cm long and ½-1 mm wide, sparsely hirtellous or subglabrous except for glands. Heads borne sometimes at least from March to November near the shore but mostly in summer above, often numerous and subcorymbose at ends of main branches, solitary or few

Figure 14. Type specimen of *Hemizonia greeneana* ssp. *peninsularis* (13437), from Punta Banda, x 0.25.

and cymose on the branchlets, yellow, 11-18 mm wide, mostly 8-rayed, but some early ones with more rays and the first, terminating the main branches, with as many as 14. Involucre campanulate, 4-7 mm high, 4-6 mm wide, sparsely hirsute, beset with peglike glands ca. 0.05 mm high and each tipped with a sticky yellowish globule ca. 0.1 mm thick, the bracts lanceolate, acute, cymbiform and strongly keeled in lower three-fifths and ca. 2 ½ mm wide (flattened), with hyaline margins, narrowed to a flatter thickish apex 2-3 mm long. Ray florets 8-14, the tube, 1 ½-2 ½ mm long, stipitate-glandular, the ray oblong to obovate, truncate and 2-3-crenate at apex, 4 ½-6 ½ mm long, 2 ½-3 ½ mm wide, subglabrous, the style branches slender, 2-3 mm long. Receptacular bracts 8-13 (about as many as the rays), in one series, weakly united to middle, oblanceolate, narrowly acute (ca. 30°), 5-6 mm high, to 1 ½ mm wide, herbaceous with hyaline margins, glandular, the apex sparsely long-ciliate. Disk florets 8-14 (-21), the corolla 4-5 mm long, the tube slightly ampliate above, subglabrous, the lobes triangular-ovate, ¾-1 mm long, thickened and densely puberulent ventrally on margins, the anthers yellow, ca. 2 ½ mm long, the stigma lobes ca. 2 mm long, the achenes sterile, 2-2 ½ mm long, sparsely glandular-puberulent, the pappus 1.9-3.3 mm long, the paleae 9-15, free or united at base, unequal, irregularly lanceolate or oblong, stiff, white. Ray achenes 2-3 mm long, triquetrous, black, transversely rugose, acute and stipitate at base, rounded at apex, with an upcurved lateral beak 1-2 or rarely 3 times as long as thick.

Type collection. — Occasional on east, north, and west slopes at 380 meters elevation,

summit of Banda Peak, Punta Banda, Baja California, Mexico (near 31°44½'N, 116°43¾'W), 27 August 1966, *Moran 13437* — holotype: SD 70684; isotypes: K, MEXU, UC, US, etc.

Distribution. — Local on the northwest coast of Baja California southwest of Ensenada and midway between there and Tijuana. Other collections: northfacing cliff at mouth of Río San Miguel (or Guadalupe), 5 m, *Higgins* in 1946 (SD), *Howe* in 1964 (SD), *Moran 13155, 13431, 14633, 15376, 16000;* rocky cliffs near ocean 37 miles S of border [probably the same locality], *Campbell* in 1937 (POM); Isla Sur, Islas de Todos Santos, *Brandegee* in 1897 (UC?), Moran *2803* (SBBG), *16210,* Blakley *6590* (SBBG, SD), *6598* (SBBG, SD); N side of Punta Banda near tip, 5 m, *14638;* type locality, *15914.*

Discussion. — The new subspecies apparently is local on cooler parts of the coast, occurring chiefly on Punta Banda (Banda Promontory) and on the southern one of the Islas de Todos Santos, a disconnected part of that promontory. Otherwise it has been found only on one north-facing beach cliff 20 miles to the north. The annual rainfall on the Islas de Todos Santos is about 10 inches (Hastings, 1964), and the coastal area is subject to frequent fogs. In contrast, *H. g. greeneana* is endemic to the south end of Isla Guadalupe and the offlying islets, a hot dry area, again with frequent fogs but with an annual rainfall of perhaps less than 2 inches.

This plant was first collected in 1897 on the Islas de Todos Santos by T. S. Brandegee (1899, 1900), though his specimens cannot now be found. He first thought it seemed "the same as specimens named *H. frutescens* Gray, collected by Dr. Palmer on Guadalupe Island, although neither of them exactly agrees with Dr. Gray's description of that species". But then, evidently from the same collection, he reported *H. greeneana* as "growing plentifully over the larger [southernmost] of the Todos Santos Islands." The Palmer specimens he mentioned must have been part of the type collection of *H. greeneana,* but it is not clear how Brandegee saw specimens labeled as *H. frutescens.*

As noted by Moran (1950), Dr. D. D. Keck considered the Todos Santos plant a new species; but he has never published it. His conclusion was first based only on Brandegree's collection, though apparently later supported by mine *(2803).* Material now available shows that both the original *H. greeneana,* of Isla Guadalupe, and the Todos Santos plant are more variable than was then evident, and their variation is roughly parallel. The differences noted below are mostly not clear-cut but subject to exception. Thus the two plants do not appear as different or as distinct as they might have before, and they are perhaps best treated as subspecies of one species.

Plants of *H. g. greeneana* may be prostrate in exposed places; but though commonly taller, they are still moundlike, with arching branches, even in the most sheltered places. They are generally compact, the inflorescence being densely leafy and often many flowered and even the lower internodes being short. On steep north slopes near the shore, plants of *H. g. peninsularis* also grow prostrate, and elsewhere they may have somewhat arching branches; but commonly they are more erect and more open, often with virgate branches and mostly with longer internodes below.

In *H. g. greeneana* the leaves often are glabrous except for the glands but sometimes are sparsely hirsute or villous-hirsute. The lower leaves are about 2 to 4½ cm long, seldom entire but mostly with 4 to 12 teeth or lobes. In *H. g. peninsularis* the leaves, especially the uppermost, may be glabrous except for the glands; but commonly they are hirsute or hirtellous, the trichomes on middle and upper leaves being generally shorter and stiffer than in *H. g. greeneana.* The lower leaves are commonly longer (to 7 cm) and relatively if not actually narrower, with fewer teeth or lobes, which are thus more remote.

In *H. g. greeneana* the pappus of the disk achenes is about 1.3 to 2.2 mm long, of about 6

to 11 paleae, whereas in *H. g. peninsularis* it is about 1.9 to 3.3 mm long, of about 9 to 15 paleae. The reduction in *H. g. greeneana* might seem another example of decrease or loss of dispersability in island plants (cf. Carlquist, 1966). However, the disk achenes are sterile in all species of the section *Zonamra*, to which this species belongs.

The beak of the achene in *H. g. greeneana* is mostly 2 to 3 times as long as thick, in *H. g. peninsularis* mostly 1 to 2 times as long as thick; but there are exceptions in both directions.

Hemizonia palmeri Rose, another member of the section *Zonamra*, is endemic with *H. g. greeneana* at the south end of Isla Guadalupe, but in an even smaller area. It is a smaller, prostrate, rather woody plant, with silky-strigose mostly entire leaves, the heads apparently rather constantly with 8 rays and with about 10 to 12 disk florets. Apparently *H. palmeri* flowers mainly in winter and *H. g. greeneana* more or less the year around. Hybrids are rare, and the two species remain quite distinct.

Hemizonia greeneana is more similar to *H. clementina* Brandegee and to *H. frutescens* A. Gray. *Hemizonia clementina* is restricted to five of the islands off southern California, varying somewhat from island to island (Carlquist, 1965: 115 ff.). *Hemizonia frutescens* is endemic to the high northern part of Isla Guadalupe, a cooler and moister area than the low south end where *H. g. greeneana* grows. Since the discovery of *H. frutescens* in 1875, when goats were already abundant, shrubby plants have been rare and confined to cliffs, though Greene (1885) reported it "common on level ground and hillsides and, in such places, strictly annual". It is now known only on one north-facing cliff at 800 meters elevation, where about 20 plants are visible. There it is a shrub about 6 dm high, with virgate branches. Since it is poorly represented in herbaria, detailed comparison with *H. greeneana* is difficult. In habit and leaf form, both *H. clementina* and *H. frutescens* are more similar to *H. g. peninsularis* than to *H. g. greeneana*, which is divergent perhaps in connection with the more desertic conditions under which it grows.

The heads of *H. greeneana* were described as having 8 rays, as at most seasons they do. In both subspecies, however, early heads, terminating the main branches, may have 12 to 14 rays, a corresponding number of involucral and of receptacular bracts, and a correspondingly large number of disk florets, sometimes as many as 21. Thus in head structure *H. greeneana* is intermediate between the more primitive *H. clementina* and the more advanced *H. frutescens*. Except for having only a single series of receptacular bracts, the early heads of *H. greeneana* rather closely resemble the heads of *H. clementina*, which regularly have 12 to 14 rays and 15 to 30 disk florets. As the leaves of the two also are similar, *H. g. peninsularis* in early flower can be confused with *H. clementina*. On the other hand, the *later* heads of *H. greeneana* resemble the heads of *H. palmeri* and *H. frutescens*. In *H. frutescens*, to judge from scanty (and possibly inadequate) material, the number of rays is mostly 8 and rarely 9, even in terminal heads of the main stems. *Hemizonia frutescens* differs from *H. greeneana* further in its paler and perhaps thinner leaves and its longer and softer pubescence. In form, color, and vesture of leaves, though not in habit, it bears a suggestive resemblance to putative natural hybrids of *H. palmeri* with *H. g. greeneana*.

Heterotheca martirensis Moran, spec. nov. (Fig. 10)

Planta humilis perennis, rhizomata gracilia ad 1 ½ dm longa foliis squamiformibus amplectentibus ovatis obtusis ciliatis 2-4 mm longis instructa emittens. Caules graciles, 1-10 cm longi. Folia spatulata, mucronata, 1-2 ½ cm longa, 3-7 mm lata, vulgo utrinque hirsuta. Capitula solitaria, discoidea, flava, plerumque 20-42-flora, pedunculis gracilibus 1-6 cm altis 0-2-bracteatis. Involucra campanulata, 6-9 mm alta, 4-6 mm lata, bracteis 24-48, in 3-4 seriebus imbricatis, lanceolatis, acutis, margine scariosis purpurascentibusque, exterioribus ca. 2 x ½ mm, interioribus ad 8 x 1-1 ½mm. Corollae 5-7 mm longae. Achenia compressa,

cuneata, 3-4 mm longa, 0.8-1.1 mm lata, 10-costata, villosa. Pappi setae sordidae, interioribus 35-55, 4-7 mm longis, exterioribus 20-30, ½-1 ½ mm longis. Typus: Moran 15612 *(SD 69534). Ob habitum humilum rhizomatosum atque capitula solitaria discoidea insignis. Aliter in toto genere tantum* H. breweri *et* H. oregona *capitula discoidea ferunt; hae herbae erectae elatioresque sine rhizomatibus et cum capitulis plus minusve corymbosis sunt.*

Mat-forming rhizomatous perennial, from a rootcrown to 1 cm thick. Rhizomes purplish at first, to 1 ½ dm long, ca. 1 mm thick, the internodes 1-3 mm long, the scale-leaves clasping, triangular-ovate, obtuse, purple becoming brown, 2-4 mm long, hirsute-ciliate, the upper passing into foliage leaves. Herbage hirsute with spreading to ascending pluricellular white trichomes ½-2 mm long and glandular with truncate-conic white trichomes to 0.15 mm long, each tipped with a viscid yellow globule. Stems slender, 1-10 cm long above ground, erect or decumbent, mostly leafy throughout though on longer stems the lower leaves more scattered. Leaves thick, spatulate, 1-2 ½ cm long, 3-7 mm wide above, ½-1 mm wide above the broadened clasping base, mucronate with the whitish conic mucro commonly deflexed and inconspicuous, glandular throughout, closely hirsute-ciliate at base, at least sparsely hirsute on midrib dorsally but more often evenly hirsute on both surfaces, the midrib impressed ventrally and projecting dorsally, the lateral veins ca. 3 on each side, looping, mostly obscure. Heads discoid, yellow, solitary, flowering May to September, the peduncles slender, 1-6 cm tall, glandular, hirsute or not, naked or with 1 or 2 linear bracts 2-3 mm long. Involucre campanulate, 6-9 mm high, (2-) 4-6 mm wide (to 16 mm wide pressed), of 24-48 bracts well imbricated in 3 or 4 series, the bracts erect, lanceolate to linear-lanceolate, acute, herbaceous and (at least the outer) glandular, purplish-scarious at margins, fimbrillate above, with a prominent colorless or purplish midrib, the outer ca. 2 mm long and ½ mm wide, the inner to 8 mm long, 1-1 ½ mm wide. Receptacle convex, alveolate. Florets (4-) 20-42; corolla slender-funnelform, 5-7 mm long, yellow or becoming saffron red, the segments erect, triangular-ovate, acute, 0.5-0.8 mm long; style branches flattened, linear, blunt, 1.5-1.9 mm long, the appendage puberulent, about equalling to twice exceeding stigmatic part. Achenes tan, cuneate, compressed, 3-4 mm long, 0.8-1.1 mm wide, 0.6-0.7 mm thick, with 10 low ribs, villous with ascending trichomes ½-1 mm long. Pappus sordid, double, the inner of 35-55 unequal slender barbellate bristles 4-7 mm long, the outer of ca. 20-30 similar bristles ½-1 ½ mm long or some of them slightly broadened and scalelike. Somatic chromosome number: $2n = 18$.

Type collection. — Common in crevices on flat granitic surfaces at 2800 meters elevation, north slope of Cerro "2828", east rim of the Sierra San Pedro Mártir, Baja California, Mexico (near 31°02'N, 115°27'W), 14 September 1968, *Moran 15612* — holotype: SD 69534; isotypes: K, MEXU, UC, US, etc.

Distribution. — Rather common, mostly on rocks, in full sun or partial shade, at 2050 to 2800 meters elevation in the north central Sierra San Pedro Mártir. Other collections: Cerro Venado Blanco, 2750 m, *15634;* E slope at head of Arroyo Copal, 2500 m [seen to 2300 m], *15435;* 2 miles E of Corral de Sam, 2050 m, *16531;* type locality, *15053;* SW slope above Yerba Buena, 2500 m, *Moran & Thorne 14196, Moran 15067;* Los Llanitos, 2500 m, *Moran & Thorne 14257.*

Discussion. — The new species is placed in *Heterotheca* Cass. as emmended by Shinners (1951) to include *Chrysopsis* (Nutt.) Ell. The only other species with discoid heads are *H. breweri* (A. Gray) Shinners and *H. oregona* (Nutt.) Shinners, both erect herbs with branching stems bearing several heads. From both these species, *H. martirensis* differs conspicuously in its low and rhizomatous habit, its solitary pedunculate heads, and its better developed outer pappus. Very likely it is more closely related to some of the radiate species of the Rocky Mountain area. In particular, it is similar in habit, leaf shape (including the

mucronate tip), and pubescence, to *Chrysopsis jonesii* Blake, of southern Utah, though that plant is more compact, with smaller leaves and smaller sessile heads.

Brandegee (1893) listed *Chrysopsis* sp. from the Sierra San Pedro Mártir with no comment. I have seen no collection of his.

For the type collection of *H. martirensis*, Dr. R. C. Jackson reports a somatic chromosome number of $2n = 18$.

Stephanomeria monocephala Moran, spec. nov. (Fig. 11)

Planta pulvinata, ad 3 dm lata. Folia rosulata 5-15 oblanceolata, acuta, ½-3½ cm longa, 1-5 mm lata, sparsim glanduloso-puberulenta, superne utraque margine inaequaliter 0-3-dentata. Pedunculi ½-8 cm alti, superne 0-2-bracteati. Capitula solitaria, 14-21 mm diametro, 5-8-flora. Involucra cylindracea, 7-9 mm longa, 2-3 mm lata, bracteis lanceolatis, interioribus 5-9 aequalibus, exterioribus 3-5 imbricatis. Corollae tubus 2½-4 mm longus, ligula rosea, 4½-9 mm longa, 2½-4½ mm lata, elliptico-oblonga, truncata, apice 5-lobata. Achaenia prismatica, 2½-3 mm longa, lateribus anguste sulcata, costis minute scaberulis. Pappi setae persistentes, albae, biseriatae, interioribus 20, fere ad basin plumosis, 4-6 mm longis, exterioribus alternantibus, minutis. Typus: Moran 15261 *(SD 68877). Species habitu pulvinato et capitulis solitariis distinctissima, pappi setis exterioribus minutis etiam insignita.*

Plant cespitose, forming dense cushions to 3 dm wide and 1 dm high, the interstices packed solid with soil. Stems 2-5 mm thick, each branch with a rosette of ca. 5-15 leaves and covered below with persistent dead leaves. Leaves oblanceolate to linear-oblanceolate or occasionally spatulate, mostly acute, entire or commonly 1-3-dentate on each margin above, ½-3½ cm long, 1-5 mm wide above, ½-1½ mm wide above the broadened base, subglabrous or (in the same plant) commonly glandular-puberulent with pluricellular trichomes ca. 0.1 mm long, the teeth spreading or slightly reflexed, triangular, the upper mostly longer, to 1 mm long, the midrib prominent, the lateral veins obscure. Peduncle terminal ½-5 (-8) cm tall, slender, striate or angled, glandular-puberulent, often with 1 or 2 small lanceolate bracts above. Heads solitary, 10-12 mm high, 14-21 mm wide, with 5-8 but commonly 6 florets, flowering May to July. Involucre cylindric, 7-9 mm long, 2-3 mm wide, of 5-9 but mostly 6 equal bracts and 3-5 graduated shorter ones, the bracts lanceolate, acute to narrowly rounded, 1-2 mm wide, green or purplish with scarious margins, minutely granular-glandular and often also sparingly glandular puberulent, the longer ones sparsely villous at apex. Receptacle shallowly pitted, glabrous. Corolla 7-13 mm long, the tube whitish, 2½-4 mm long, with a few scattered trichomes ventrally above, the ligule light to deep pink or rarely white, elliptic-oblong, truncate and 5-lobed, 4½-9 mm long, 2½-4½ mm wide, the lobes 1-1½ mm long and a third as wide, triangular-ovate, obtusish. Anthers 3½-5 mm long, sagittate at base; pollen white. Style 7-12 mm long, lavender above, ascending-puberulent, the style branches ca. 1 mm long. Achenes light tan, pentagono-prismatic, only slightly narrowed towards base and apex, 2½-3 mm long, 0.8-1.0 mm thick, the sides slightly channeled or nearly flat except for a straight shallow longitudinal groove ca. 0.1 mm wide, the angles sparsely and minutely ascending scaberulous. Pappus persistent, white, 4-6 mm long, double, the inner bristles ca. 20, stiff, slightly widened and connate at base, plumose nearly to base with pinnae 0.3-0.5 mm long, the outer bristles inconspicuous, alternating, very slender, smooth or scaberulous, mostly less than 1 mm long.

Type collection. — Common in crevices of north- and east-facing rocks and cliffs at 2800 meters elevation, Cerro "2828", east rim of the Sierra San Pedro Mártir, Baja California, Mexico (near 31°02'N, 115°27'W), 5 July 1968, *Moran 15261* — holotype: SD 68877; isotypes: K, MEXU, UC, US, etc.

Distribution. — Known only from the type locality. Other collections: *15064, 15332, 15403, 16533.*

Discussion. — This plant appears to be quite limited as to habitat: despite wide collecting in the general area on several trips, I found it only in the one place. However, there are several similar cliffs on the east rim where it probably can be expected. Associated species include *Selaginella asprella* Maxon, *Sedum niveum* Davids., *Heuchera leptomeria* var. *peninsularis* Rosend., Butt., & Lak., *Saxifraga eriophora* S. Wats., *Potentilla wheeleri* S. Wats., *Haplopappus pulvinatus* Moran, and *Tanacetum bajacalifornicum* Moran.

Stephanomeria monocephala differs from others of the genus in its polster habit and solitary heads. The regular outer series of minute pappus bristles also is noteworthy; but although the pappus of *Stephanomeria* is always described as uniseriate, a variable number of similar tiny bristles occurs in several other species.

In other floral and fruiting characters, *S. monocephala* appears to be an average member of the genus. However, it differs from every other species in some combination of characters of involucre, flowers, achenes, and pappus. Mr. Leslie D. Gottlieb, a student of the genus, suggests that it is closest to *S. lactucina* A. Gray, native from eastern Oregon to Nevada and the Sierra Nevada. That is a larger plant, with stems arising singly from slender rootstocks and usually bearing several heads; the heads are larger, with more and larger florets; and the achenes are larger.

Tanacetum bajacalifornicum Moran, spec. nov. (Fig. 15)

Herba aromatica caespitosa perennis, trichomatibus biramosis sparsim instructa. Folia basalia 2-5 cm longa, 1-2 cm lata, plerumque biternate divisa, segmentis linearibus, obtusis, 1-1 ½ mm latis, petiolo laminam excedenti. Caulis florifer 1-2 dm altus, capitulum unum vel pluria ferens, foliis superioribus integris. Involucra hemisphaerica, 4-6 mm alta, 4-8 mm lata, bracteis 13-25, 3-seriatis, ellipticis, 1 ½-3 mm latis, marginibus scariosis purpurascentibus. Receptaculum nudum. Flores marginales pistillati 6-15, corollis 2 ½ mm longis, 4-dentatis. Flores disci perfecti 40-150, corollis 3 mm longis. Pappus nullus. Achenia non visa. Typus: Moran 15613 *(SD 69075). A ceteris speciebus caespitosis turmae* Sphaeromeriae *foliis caulibusque sparsim pubescentibus nec argenteis differt. A* T. capitato, *cui foliorum forma similis est, capitulis majoribus minusque confertis, bracteis numerosioribus, et floribus numerosioribus majoribusque praeterea differt.*

Aromatic cespitose perennial, to 2 dm wide. Caudex to 2 dm long and to 1 cm thick at base, the branches 2-5 mm thick, brown below with persistent shingled leaf bases. Herbage at first thinly canescent with appressed crinkly biramous hairs, at maturity mostly subglabrate. Leaves alternate, thick, glandular pitted, the basal ones ca. 10-15, crowded, 2-5 cm long, the base thin, clasping, ca. 4 mm wide, the petiole exceeding the blade, strap-shaped, ca. 1 mm wide, the blade 1-2 cm wide, biternately divided or some pedately or pinnately and then ternately divided, the segments linear or oblong, obtuse, 1-1 ½ mm wide. Floral stems terminal, nodding at first, slender, 1-2 dm tall, low ridged, with 10-15 linear leaves ca. 1 mm wide, the lower 1-2 cm long, ternately divided near apex, the upper shorter and entire. Heads whitish, solitary or with 1-2 smaller ones crowded below or with a few additional small ones scattered in upper axils. Involucre hemispheric, 4-6 mm high, 4-8 mm wide (to 10 mm wide pressed), the bracts 13-25, in about 3 nearly equal series, elliptic, acute to rounded, 4-6 mm long, 1 ½-3 mm wide, the midpart stiff coriaceous below, in all but the innermost thick and green and somewhat glandular above, the broad margins scarious, purplish, erose, piloseciliate in lower half, the inner narrower. Receptacle conoidal, naked, 1 ½-3 mm high and thick. Pistillate marginal florets 6-15; corolla ca. 2 ½ mm long, tubular, nearly regular, with 4 triangular teeth; style branches ca. 0.6 mm long, well exserted. Perfect disk florets ca. 40-

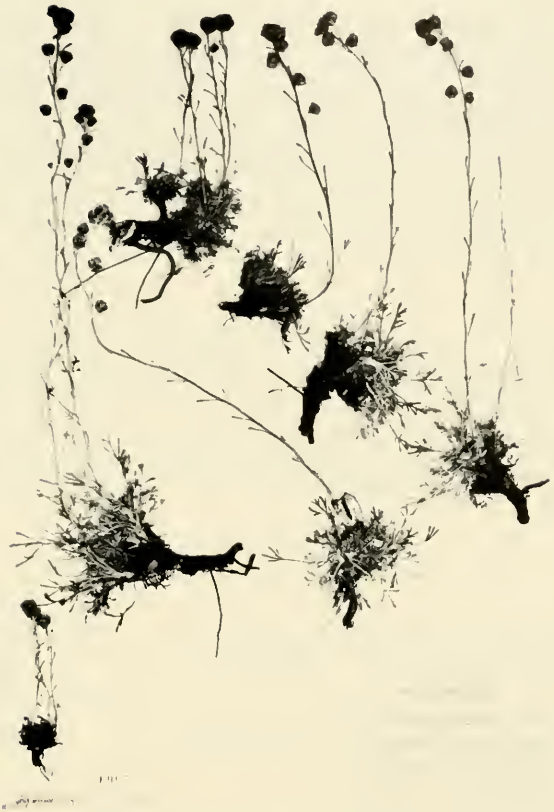

Figure 15. Type specimen of *Tanacetum bajacalifornicum* (15613), from the high Sierra San Pedro Mártir, x 0.25.

150; corolla ca. 3 mm long, the tube equalling the conspicuously widened throat plus the 5 triangular teeth; style branches 0.6 mm long. Pappus none. Mature achenes not seen.

Type collection. — Common, mostly in rock crevices, north slope of Cerro "2828" at 2800 meters elevation, Sierra San Pedro Mártir, Baja California, Mexico (near 31°02'N, 115°27'W), 14 September 1968, *Moran 15613* — holotype: SD 69075; isotypes: K, MEXU, UC, US, etc.

Distribution. — On rocks and cliffs near the east rim of the Sierra San Pedro Mártir, at 2500 to 2800 meters elevation. Other collections: rock crevices of S summit ridge, Cerro Venado Blanco, 2750 m, *15637;* on rocks under pines and firs, E slope above Arroyo Copal, 2500 m, *15521;* rock crevices on E slope of Cerro "2828", 2800 m, *15411.*

Discussion. — *Tanacetum bajacalifornicum* belongs to the *Sphaeromeria* group, characterized in part by the lack of rays in the pistillate marginal flowers and by the presence of malpighiaceous hairs. This group is centered in the Great Basin, and *T. bajacalifornicum* is isolated some 375 miles south of the nearest other member. The other cespitose members of the group have silvery canescent rather than sparsely pubescent herbage; and they differ from *T. bajacalifornicum* further as follows (cf. Rydberg, 1916). In *T. capitatum* (Nutt.) T. & G., ranging from Montana to Utah, which is most similar in leaf form, the heads are smaller and more crowded, with fewer involucral bracts and with far fewer and slightly

smaller florets. In *T. compactum* Hall, of the Charleston Mountains, Nevada, the plant is smaller, the lower leaves are flabellately 5-parted into 3-lobed divisions and the upper pinatisect, and a pappus is fairly well developed. In *T. potentilloides* A. Gray, ranging from Oregon and Idaho to Nevada and eastern California, the leaves are pinnately to tripinnately divided, the involucral bracts fewer, the receptacles white-hairy, and the florets smaller. In *T. nuttallii* T. & G., ranging from Montana to Nevada, the leaves are cuneate and entire or 3-5-lobed at the summit, the involucral bracts shorter and fewer, and the florets smaller. In *T. simplex* Nels., of Wyoming, the leaves are entire or bifid or trifid at the apex, the floral stems shorter, and the heads solitary.

ACKNOWLEDGEMENTS

I am grateful to Drs. Lincoln Constance, Peter Raven, and Robert F. Thorne, for critically reviewing all or part of the manuscript. Drs. R. C. Jackson, James L. Reveal, and Charles H. Uhl have kindly made chromosome counts. The maps are by Miss Gayle Culver.

Plants were collected under a series of permits kindly issued by the Dirección General de Aprovechamientos Forestales of the Secretaría de Agricultura y Ganadería of the Mexican Government; and in accordance with the terms of the permits, specimens are being deposited in the Forestry Herbarium in Coyoacán.

LITERATURE CITED

Barkley, F. A.
1937. A monographic study of *Rhus* and its immediate allies in North and Central America, including the West Indies. Ann. Missouri Bot. Gard. 24: 265-498.

Brandegee, T. S.
1891. Flora of the Cape Region of Baja California. Proc. Calif. Acad. ser. 2, 3: 108-182.
1893. Southern extension of California flora. Zoe 4: 199-210.
1899. Island flora notes. Erythea 7: 70-71.
1900. Voyage of the *Wahlberg*. Zoe 5: 19-28.
1903. Notes and new species of Lower California plants. Zoe 5: 155-174.

Britton, N. L., and J. N. Rose
1903. New or noteworthy North American Crassulaceae. Bull. N.Y. Bot. Gard. 3: 1-45.

Carlquist, S.
1965. Island life: a natural history of the islands of the world. Natural History Press, Garden City, New York. 451 p.
1966. The biota of long-distance dispersal. II. Loss of dispersibility in Pacific Compositae. Evolution 20: 30-48.

Epling, C. C.
1925. Monograph of the genus *Monardella*. Ann. Missouri Bot. Gard. 12: 1-106.

Epling, C. C., and W. S. Stewart
1939. A revision of *Hedeoma*, with a review of allied genera. Repert. Spec. Nov. Beih. 115: 1-49.

Greene, E. L.
1885. Studies in the botany of California and parts adjacent, II. Bull. Calif. Acad. 1: 179-228.

Hastings, J. R.
1964. Climatological data for Baja California. Techn. Rep. Meteor. Climat. Arid Reg. 14: 1-132. Univ. Arizona.

Kearney, T. H., and R. H. Peebles
1951. Arizona flora. University of California Press, Berkeley. 1032 p.

Moran, R.
1950. Plants of the Todos Santos Islands, Baja California. Leafl. West. Bot. 6: 53-56.
1951. Notes on the flora of Guadalupe Island, Mexico. Madroño 11: 153-160.

Pennell, F. W.
1935. The Scrophulariaceae of eastern temperate North America. Monogr. Acad. Sci. Philadelphia 1: 1-650.

1951. Scrophulariaceae. *In* L. R. Abrams, Illustrated flora of the Pacific States, vol. 3. Stanford University Press. 866 p.

Rydberg, P. A.
1916. Carduaceae: Tageteae, Anthemideae. N. Amer. Flora 34 (3): 181-288.

Shinners, L. H.
1951. The north Texas species of *Heterotheca*, including *Chrysopsis* (Compositae). Field & Lab. 19: 66-71.

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OBSERVATIONS ON A YOUNG PYGMY KILLER WHALE (*FERESA ATTENUATA* GRAY) FROM THE EASTERN TROPICAL PACIFIC OCEAN

WILLIAM F. PERRIN AND CARL L. HUBBS

TRANSACTIONS

OF THE SAN DIEGO
SOCIETY OF
NATURAL HISTORY

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WILLIAM F. PERRIN AND CARL L. HUBBS

ABSTRACT. — An early juvenile specimen of *Feresa attenuata* was captured in May 1967 during commercial tuna fishing operations off Costa Rica. This is the first record of this species from the eastern Pacific and from North American waters. Discrepancies in external morphology and in osteology were noted between the specimen and earlier described adult specimens from Hawaii, Japan, and Senegal, but full analysis of the differences must await the capture of adult animals from the eastern Pacific or juveniles from the other parts of the range.

RESUMEN. — En mayo 1967, durante las operaciones comerciales de pesca atunera frente a Costa Rica, se capturó un espécimen juvenil de *Feresa attenuata* en su primer ciclo vital. Esta especie es la primera registrada en el Pacífico oriental y en aguas norteamericanas. Se observaron diferencias en la morfología externa y en la osteología entre este espécimen y espécimenes adultos descritos anteriormente, provenientes del Hauái, Japón y Senegal, pero el análisis completo de las diferencias no se obtendrá hasta que se capturen animales adultos del Pacífico oriental o juveniles de otros lugares en los límites de distribución.

The pygmy killer whale, *Feresa attenuata* Gray (1875), is one of the least known of the delphinids. Gray (1871) based the genus *Feresa* on a skull first described as *Delphinus intermedius* Gray, from an unknown locality. Gray (1875) later proposed the species *Feresa attenuata* on the basis of another skull, from the "South Seas." The synonymy and nomenclature of the species have been elucidated by Fraser (1960).

The external appearance of the animal remained unknown and its geographical distribution remained almost undetermined for three-fourths of a century, until Yamada (1954) described a specimen from Taiji, Honshu, Japan, and gave it the vernacular name used here. Thereafter the known range of the species was rapidly expanded, and its characters were made more fully known. Cadenat (1958) and Fraser (1960) reported on a specimen from Senegal, Africa. Nishiwaki et al. (1965) dealt with further material from Japan. Pryor, Pryor, and Norris (1965) described a specimen from Hawaii. There is no evidence that this species has ever occurred in Australia (Dawbin, pers. comm.; cf. Slijper, 1962: 345).

There has been no previous evidence that *Feresa attenuata* occurs in the eastern Pacific, although Hall and Kelson (1959: 830) stated that it "may occur in Pacific waters of North America." Possibly it was observed long ago in the tropical eastern Pacific, but Scammon's (1874: 104) description of the "Panama grampus" in Bahía de Panamá is not sufficiently detailed to allow specific identification.

The first definite indication of *Feresa attenuata* in the eastern Pacific Ocean is furnished by a juvenile male specimen taken in early May, 1967, approximately 300 to 400 nautical miles off Costa Rica. It was collected by Anthony Dutra, a commercial fisherman of San Diego, California, during tuna-seining operations, such as have recently been described (Perrin, 1969). The net had been set on a school of "whitebelly porpoise," presumably *Delphinus* sp. Mr. Dutra recognized the specimen as representing a species that he had never seen before and saved it in the ship's freezer. It is almost certain that this juvenile porpoise was accompanied by its mother, which apparently escaped during the purse-seining operation. On return to San Diego, Mr. Dutra had a trophy cast made by a

taxidermist, who brought the carcass (Fig. 1) to Scripps Institution of Oceanography for identification. The specimen was identified as a juvenile male of *Feresa attenuata* on the basis of form, size, coloration, and tooth number. The specimen was photographed, measured, and skeletonized. The flippers and flukes were reconstructed from measurements and tracings of the cast. The skeleton, a cast, and drawings of the flippers and flukes are deposited in the Natural History Museum of the San Diego Society of Natural History (No. 21561).

Whether this delphinid regularly inhabits eastern Pacific waters is unknown. That an experienced and interested tuna fisherman recognized the specimen as of a species he had never seen before, and that the species has not previously been observed by us or by colleagues during extensive operations in the area of the eastern Pacific where tuna are commonly caught, suggests that the juvenile (and the adult female) may have been a straggler to the eastern Pacific from the Indo-Pacific area, in which respect this species would be far from unique among marine organisms of the tropical Pacific (Ekman, 1953; Briggs, 1961; Hubbs and Rosenblatt, 1961; Rosenblatt and Walker, 1963).

The general offshore area wherein the specimen was caught is about the warmest in the eastern Pacific, with mean surface temperatures averaging about 28° C. during May (LaViolette and Seim, 1969). This might be taken to indicate that the species is of high-seas, tropical distribution, but other records of the species hardly confirm this. Whereas the first specimen from Japan (Yamada, 1954) and the specimen from Hawaii (Pryor et al., 1965) were captured in areas and during months when the surface temperatures average approximately 26.5 and 23.5° C., respectively (LaViolette and Seim, 1969), the later specimens from Japan (Nishiwaki et al., 1965) were taken from water at 13.5° C., in January, 1963. This wide range of occurrence relative to water temperature leaves us with little basis for predicting the probable distribution of the species.

EXTERNAL MORPHOLOGY

The specimen from off Costa Rica was a juvenile male 822 mm. long, from tip of upper jaw to the notch in the flukes. Unerupted teeth and the small size indicate that the animal may have been newly born. As received by the authors, minus flippers, fluke tips, and viscera, and probably somewhat dehydrated by freezing, it weighed 9.37 kg. It does not seem to differ from previously described specimens except in respects that reflect its youth.

External measurements were taken of the young specimen for comparison with those recorded by Pryor et al. (1965) for an adult male from Hawaii and by Nishiwaki et al. (1965) for 14 adult specimens and 1 fetus from Japan. Our measurements were made point-to-point on the left side, with a large pair of precision calipers. Pryor et al. and Nishiwaki et al. made their measurements according to the methods proposed by the Committee on Marine Mammals of the American Society of Mammalogists (1961), which for several applicable dimensions specify axial projections rather than point-to-point measurements. We feel that the point-to-point method is the more precise, is readily applicable for smaller cetaceans, and yields values that are convertible into axial projections, provided that good photographs in several aspects have been made. Our measurements in millimeters, with thousandths of total length from the tip of upper jaw to notch in flukes in parentheses (computed from axial projections where appropriate), were: total length to notch of flukes, 822; tip of upper jaw to center of eye, 82(100); tip of upper jaw to end of gape, 69(84); tip of upper jaw to blowhole, 76(92); tip of upper jaw to insertion of flipper, 186(226); tip of upper jaw to origin of dorsal fin, 389(473); tip of upper jaw to tip of dorsal fin, 521(634); tip of upper jaw to midpoint of umbilicus, 393(478); tip of upper jaw to midpoint of genital aperture, 485(590); tip of upper

Figure 1. *Feresa attenuata*. Top to bottom: right lateral view; dorsal view; ventral view; close-up of head in right lateral view.

jaw to center of anus, 555(675); tip of upper jaw to origin of flukes, 747(909); tip of upper jaw to plane of maximum girth, 379(461); maximum girth, 554(674); girth at axilla, 540(657); girth below origin of dorsal fin, 540(657); girth above anus, 302(367); center of eye to end of gape, 31(38); eye length, 17(21); eye height, 9(11); blowhole length, 6(7); blowhole width, 18(22); length of slit from umbilicus to anus, 155(189); length of mammary slit, 2(2); length of anal slit, 13(16); insertion to tip of flipper, 160(195); maximum width of flipper, 58(71); height of dorsal fin, 77(94); length of dorsal fin base, 130(158); tip to tip of flukes, 210(255); notch to nearest margin of fluke, 73(89); thickness of blubber at origin of dorsal fin, 13(16).

Some of the proportions for the eastern Pacific specimen, despite the discrepancies in age, fall within the ranges given for other specimens. A notable exception is the girth, which probably was affected by the stuffing of our specimen during the casting process. In a number of the proportions, those involving the dimensions of the anterior parts, the eastern Pacific specimen has high or extreme values. This can be taken to reflect the youth of our specimen. For these measurements, the fetus from Japan was even more extreme.

The long ventral groove extended from the umbilicus to the anus, as in the previously described adult specimens. Four bristle follicles were visible on the right side of the upper jaw and three on the left side.

Repeated freezing and thawing of our specimen no doubt obscured some of the more labile features of the pigmentary pattern, such as the pale lateral area described by Nishiwaki et al. (1965). In the discernible pattern, however, our specimen resembled the one from Hawaii (Pryor et al., 1965) more closely than those from Japan (Yamada, 1954; Nishiwaki et al., 1965), in that the ventral white patch extended from around the umbilicus in a narrow wedge past the anus almost to the caudal end of the tail stock, rather than ceasing at the anus. A prominent light patch between the flippers corresponded roughly with the gray area described by Nishiwaki et al.

White markings edged each jaw, the upper the more conspicuously and the more extensively. On the upper jaw the whitish areas broadened anteriorly, but these were separated by a blackish area on the midline and tended to grade above into the blackish snout, whereas posteriorly the coal-black and pure-white areas contrasted fully along the line of contact. The white margin on the lower jaw was much narrower, and was largely confined to the front of the mouth. No trace was evident of the irregular white blotches that Pryor et al. (1965) observed, and regarded as scars, in the adult male from Hawaii.

SKELETON

The entire skeleton was preserved to augment the very limited material available of this species. Because the specimen was a juvenile, perhaps newly born, the skull was very incompletely ankylosed, and some of the postcranial elements were incompletely ossified (Figs. 2-8).

Our measurements of the skull in millimeters (with thousandths of condylobasal length in parentheses) were: condylobasal length, 198.5; length of rostrum, 76.5(385); width of rostrum at base, 50.3(253); width of rostrum at mid length, 37.9(191); width of premaxillae at midlength, 21.9(110); greatest width of premaxillae, 46.9(236); tip of rostrum to anterior margin of superior nares, 105.3(530); preorbital width, 95.5(481); postorbital width, 109.8(553); midorbital width, 101.2(510); maximum width of blowhole, 30.3(153); zygomatic width, 109.5(552); length of left mandible, 144.3(727); length of right mandible, 143.5(723); left coronoid height, 39.3(201); right coronoid height, 40.5(204); length of symphysis, 11.1(56); length of left upper tooth row, 51.5(259); length of right upper tooth row, 52.4(264); end of left upper tooth row to tip of premaxillae, 61.4(309); end of right upper

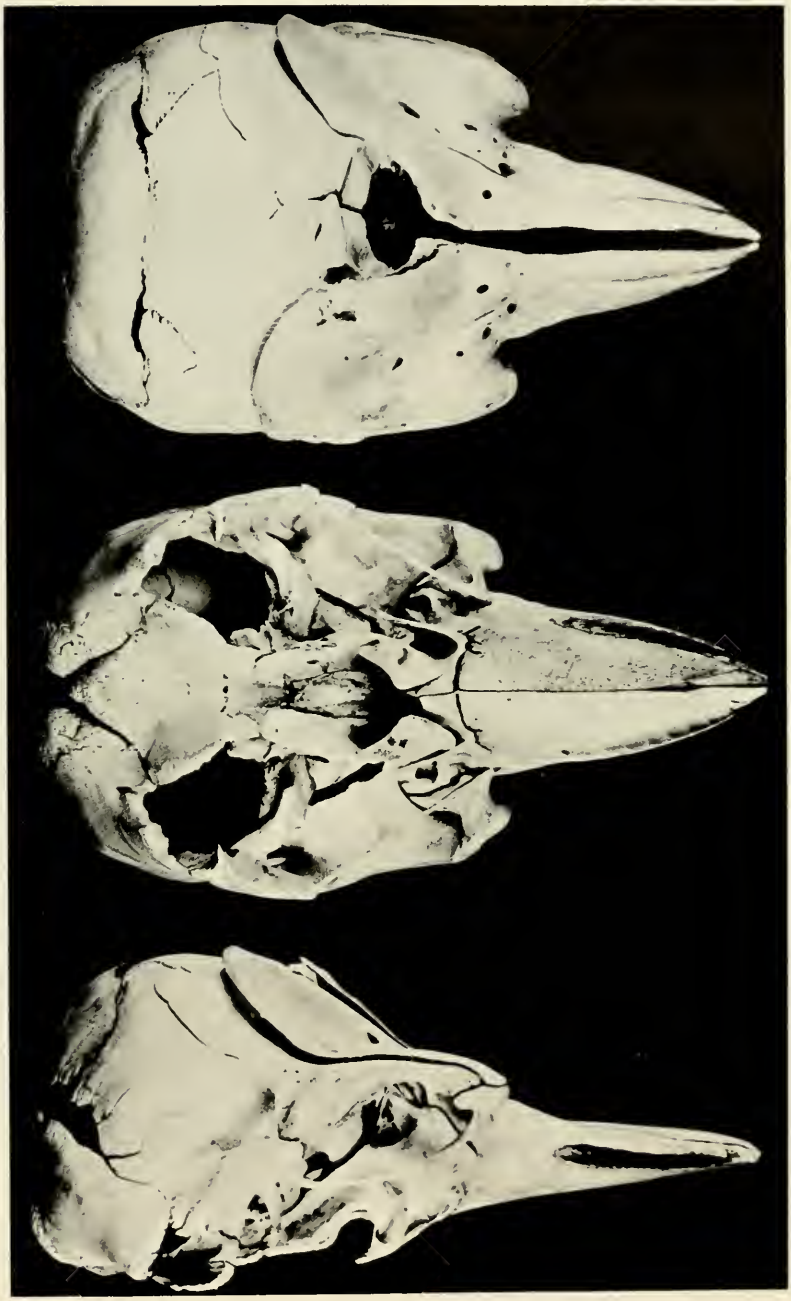

Figure 2. Skull of *Feresa attenuata*. Top to bottom: dorsal view; ventral view; right lateral view.

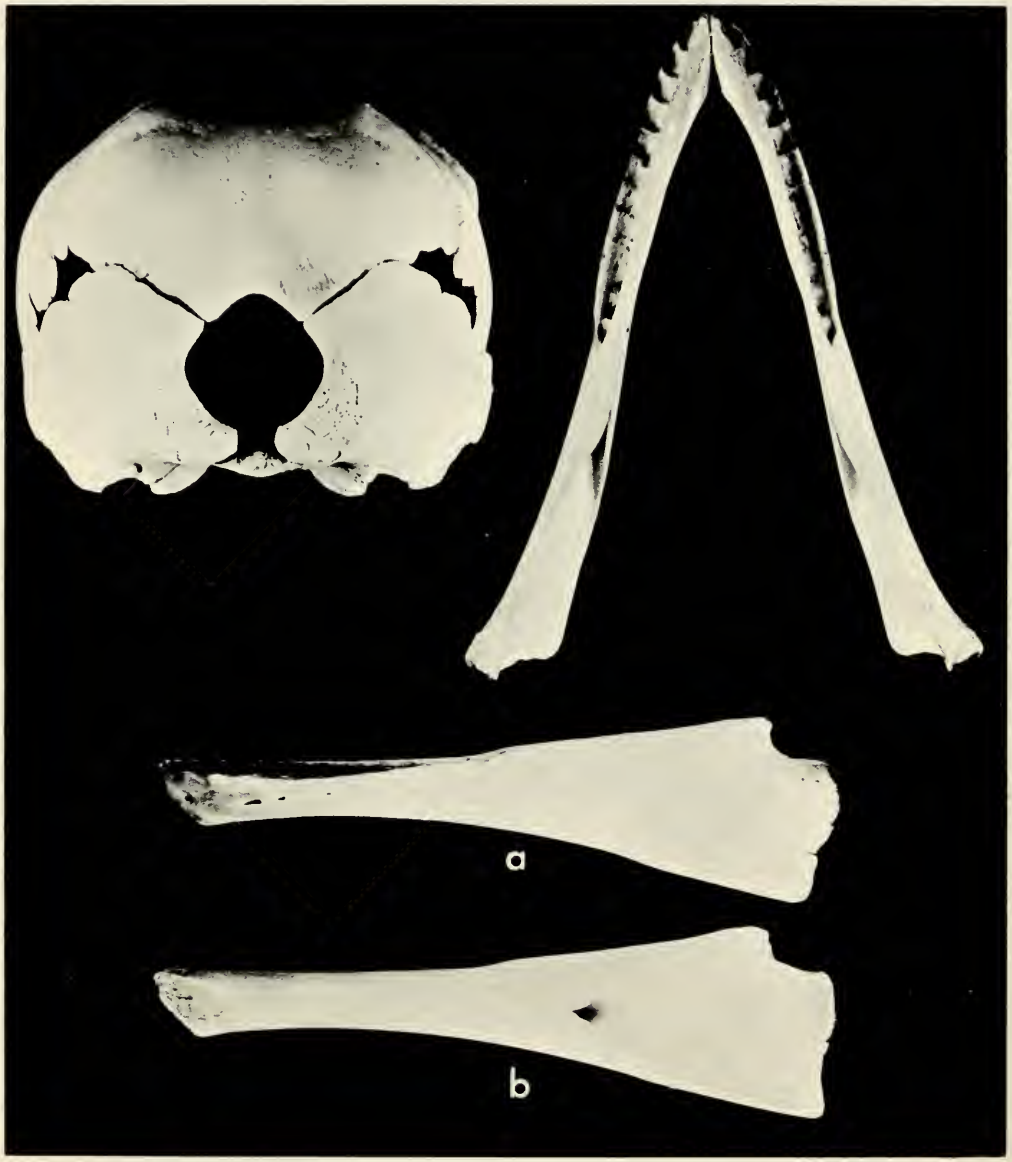

Figure 3. *Feresa attenuata*. Top left, posterior view of skull; top right, mandible, dorsal view; bottom (a) right ramus of mandible, medial view; (b) left ramus of mandible, lateral view.

tooth row to tip of premaxillae, 62.6(315); length of left lower tooth row, 70.1(353); length of right lower tooth row, 71.4(360); end of left lower tooth row to tip of mandible, 73.2(369); end of right lower tooth row to tip of mandible, 74.4(375); length of bulla of left tympano-periotic complex, 33.7(170); width of bulla of left tympano-periotic complex, 21.4(108); internal length of the braincase, 91.2(459). The tooth counts were 9/9 in the upper jaw and 12/12 in the lower jaw for a total of 42 teeth.

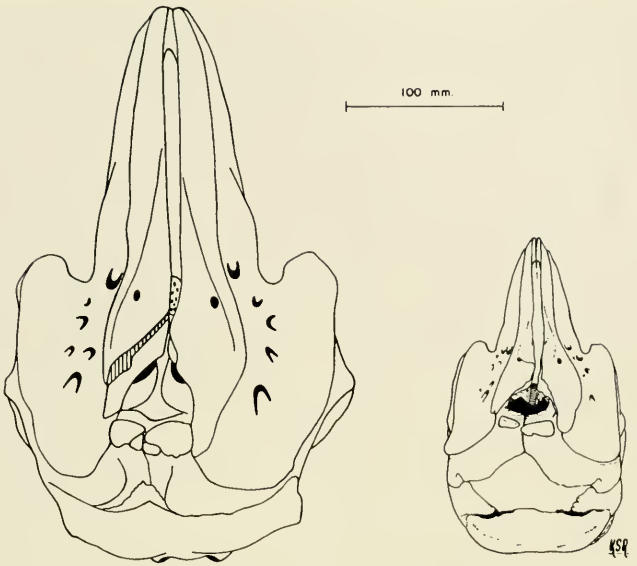

Figure 4. Left, skull of type of *Feresa attenuata* B.M.N.H. no. 1874.11.25.1 (after Fraser, 1960). Right, skull of juvenile specimen from Costa Rica, S.D.S.N.H. no. 21561.

Measurements of the skull were compared with those for the type specimen of *Feresa attenuata* (British Museum No. 1672a); for the type specimen of *F. intermedia* (British Museum No. 362a), synonymized with *F. attenuata* by Fraser (1960); and for recently collected adult specimens from Hawaii, Japan, and Senegal. Differences in proportions between the Costa Rica juvenile and the adults from other areas presumably are due to great ontogenetic changes in skull structures. However, as the skull of the juvenile became disarticulated during maceration, it is possible that proportions calculated from measurements made after the cranium had been reassembled are slightly distorted.

The juvenile from off Costa Rica differs strikingly from the adults in the small proportionate size of the rostrum (Fig. 4); this is consonant with the general pattern of development in mammals, especially those with large brains: the areas concerned with feeding grow more slowly than the brain case. The dentigerous portions of the jaws are also

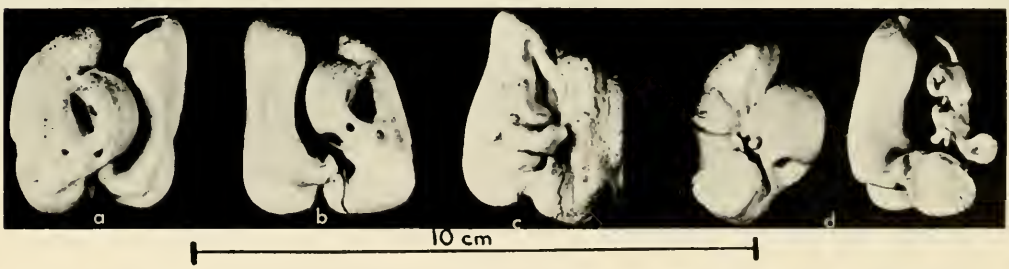

Figure 5. *Feresa attenuata*. (a) left tympano-perioticum, medial view; (b) right tympano-perioticum, medial view; (c) left tympano-perioticum, lateral view; (d) right tympano-perioticum disarticulated to show stapes (left), incus and malleus.

Figure 6. Left and right vertebral ribs of *Feresa attenuata*. Anterior most ribs at top.

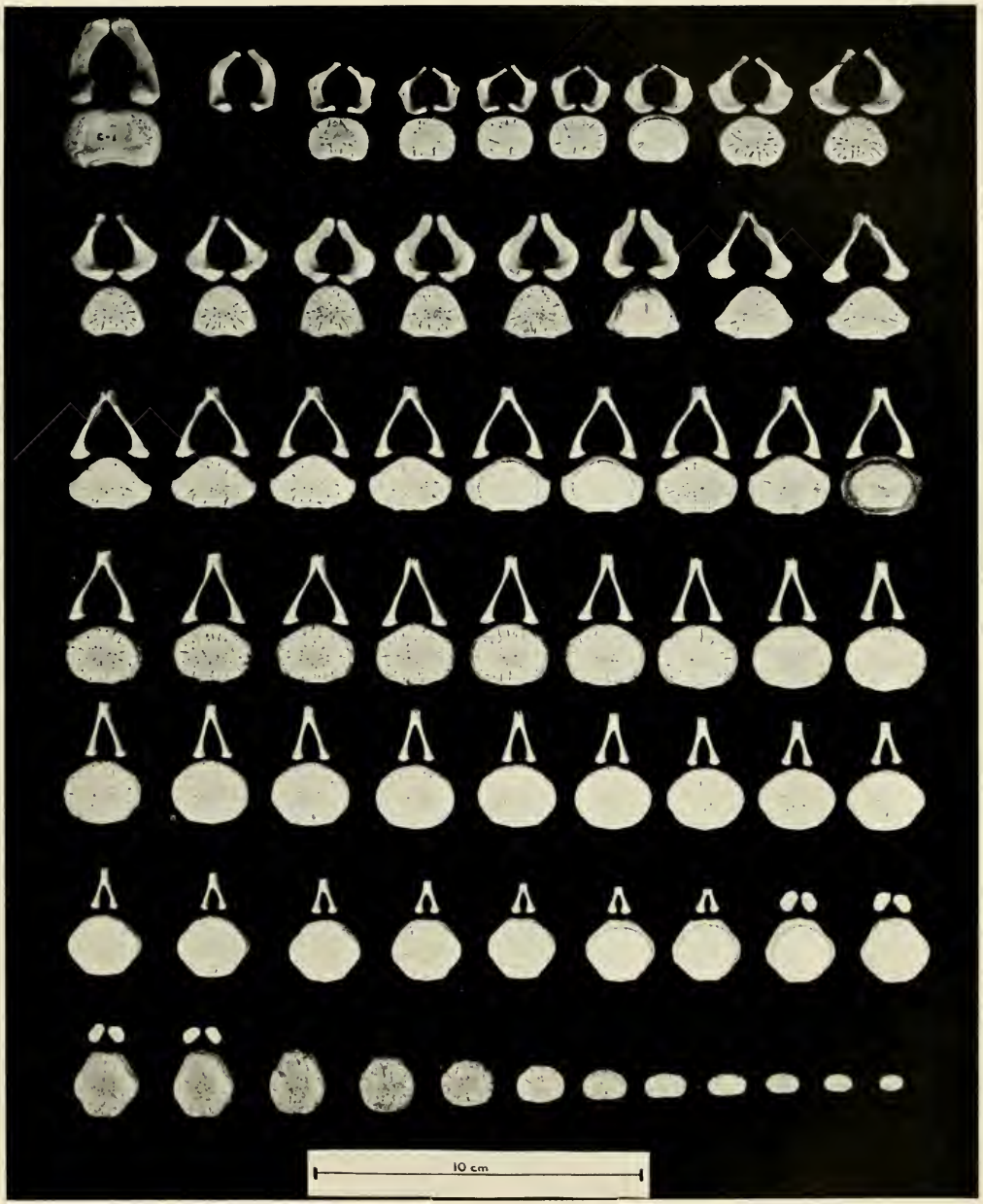

Figure 7. Vertebrae of *Feresa attenuata*, cranial view. Second cervical vertebra fused to first. Halves of neural processes on vertebrae 1-14 and 52-55 not ankylosed, shown in anteromedial view. Intervertebral discs present on some vertebrae. The vertebral column became partially disarticulated during maceration, consequently some elements may be out of order in this photograph.

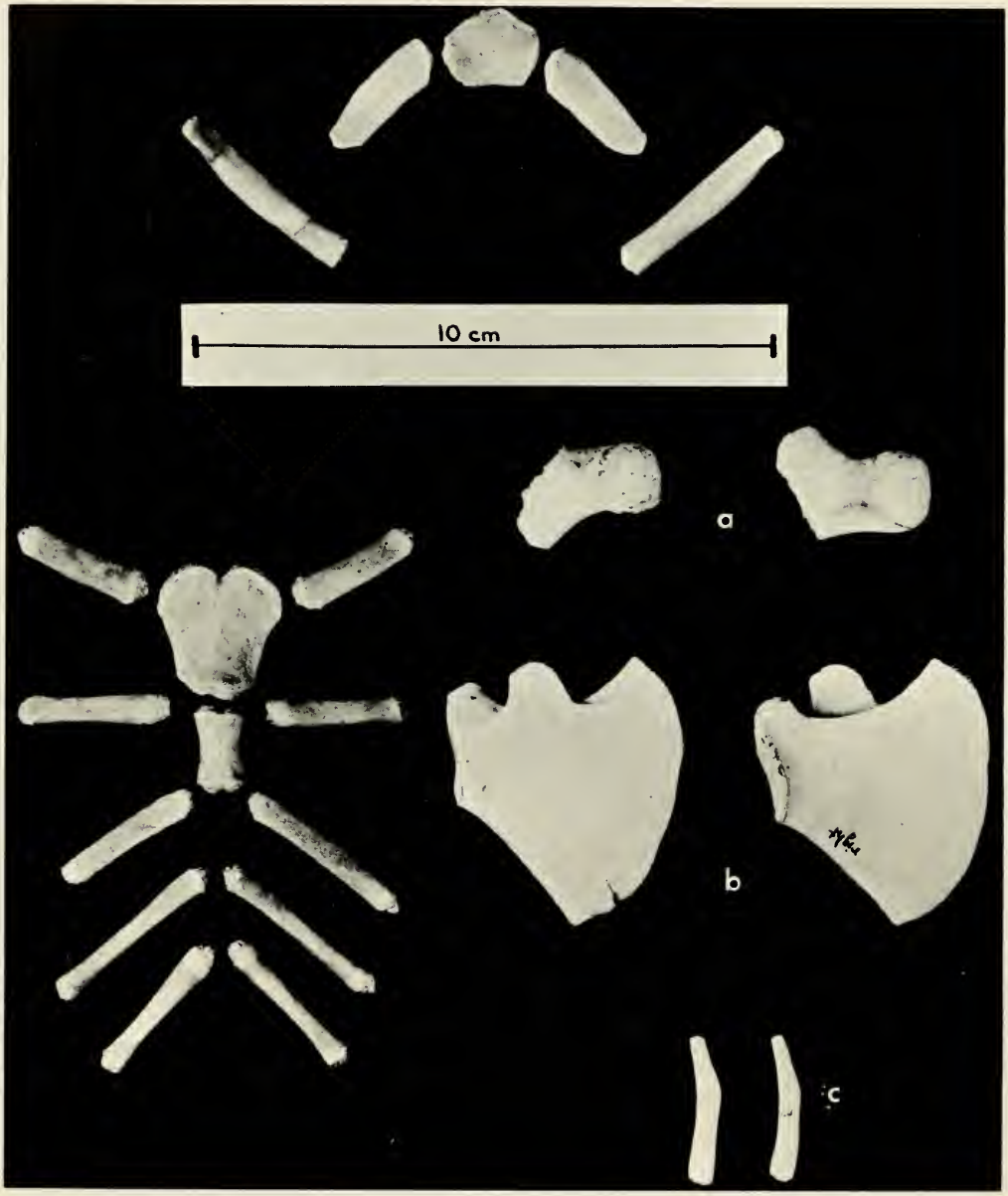

Figure 8. *Feresa attenuata.* Top, hyoid bones; bottom left, sternum and sternal ribs; bottom right, (a) proximal ends of humeri; distal ends severed and missing; (b) scapulae; (c) pelvic bones.

proportionately shorter than in the adults. The mandible (Fig. 3), however, is proportionately nearly as large as in the adult. The premaxillae are narrow near the middle, but the greatest width is not very different. The whole skull is narrower than in the adult (Fig. 4), especially in the region of the orbits and across the zygomatic arches. The condylobasal length is 1.90 times that of the parietal width in the juvenile, as compared with 1.42 to 1.73 times in the adults described by Nishiwaki et al. (1965). The skull has not become telescoped as far as in the adults: large expanses of the frontals and parietals remain visible in dorsal view.

Fraser (1960) stated that in the adult skulls of *Feresa* that he examined, the dorsal surface of the rostral portion of the premaxillae is flat and on the same level as the adjacent maxillae, a condition similar to that in *Orcinus* and *Lagenorhynchus*. In our specimen the premaxillae form a considerable convexity above the level of the maxillae (Fig. 2) in the distal two-thirds of the rostrum, a condition approaching that in adults of *Stenella*, *Tursiops*, and *Delphinus*.

The tympano-periotic complex (Fig. 5) is very large proportionately in comparison to that of the adults, viz., 170 thousandths of condylobasal length versus a range of 102 to 114 thousandths for the Japan specimens, in length; and 108 thousandths versus a range of 62 to 90 thousandths, in width of the bulla. The strong mastoid process figured by Yamada (1954) is not evident. In this respect the juvenile specimen is more like adults of *Grampus*, *Delphinus*, *Stenella* and related genera figured by Yamada (1953). The overall appearance of the tympanic bone very closely resembles that of adults of *Globicephala*, particularly in the rounded anterior end. The incus differs from those figured by Yamada (1954) in that the major crus is slenderer and the minor crus longer proportionately, and the facet at the end of the minor crus is lacking.

The vertebral formula is $C_7 T_{12} L + C_{46}$, for a total of 65 vertebrae, at least two fewer than the previously recorded minimum for the species. However, the very small terminal vertebral remnant noted by Yamada was not recovered in our preparation. The vertebral column (Fig. 7) was only partially ossified. Incompletely ossified neural processes of varying shape crested the first 55 centra, but transverse processes and chevron bones were still completely cartilaginous. The uncinate processes noted on the thoracic vertebrae of all previous specimens are not apparent. The first two cervical vertebral centra are fused. In the adult specimens from Japan, the first three to six vertebrae were fused.

The first six of the 12 pairs of vertebral ribs are two-headed, and there are five pairs of ossified sternal ribs (Figs. 6, 8). The ossified sternum (Fig. 8) consists of two unfused elements, of which the anterior one is expanded and bilobed anteriorly and the second has convex sides.

The scapulae (Fig. 8) are uneroded. The short acromion process turns anteriorly rather than posteriorly as in previously described specimens (Yamada, 1954; Pryor et al., 1965).

ACKNOWLEDGEMENTS

We thank Mr. Anthony Dutra, the fisherman who collected the specimen, provided information, and allowed us to photograph the cast which hangs in his home; and Mr. Hugh Lyons, who brought the animal to our attention and cooperated otherwise. Kenneth S. Raymond prepared figure 4. Lawrence D. Ford made the photographs of the carcass used for figure 1. Dr. Kenneth S. Norris has read the manuscript. Support was provided by the U.S. Bureau of Commercial Fisheries. The researches by Hubbs on marine vertebrates are supported by the National Science Foundation (grant GB4672).

LITERATURE CITED

Briggs, J. C.
1961. The East Pacific Barrier and the distribution of marine shore fishes. Evolution 15: 545-554.

Cadenat, J.
1958. Notes sur les Delphinidés Ouest-africains II — Un spécimen du genre *Feresa* capturé sur les côtes du Sénégal. Bull. Inst. Franç. Afrique Noire 20: 1486-1491.

Committee on Marine Mammals, American Society of Mammalogists
1961. Standardized methods for measuring and recording data on the smaller cetaceans. K. S. Norris (Ed.) J. Mamm. 42: 471-476.

Ekman, S.
1953. Zoogeography of the sea. Sidgwick and Jackson, London, 417 p.

Fraser, F. C.
1960. A specimen of the genus *Feresa* from Senegal. Bull. Inst. Franç. Afrique Noire 22: 699-707.

Gray, J. E.
1871. Supplement to the catalogue of seals and whales in the British Museum. (Not seen.)

1875. *Feresa attenuata*. J. Mus Godeffroy, Hamburg, Heft 8: 184 + pl.6.

Hall, E. R., and K. R. Kelson
1959. The mammals of North America. Ronald Press, N.Y. 2 vols.

Hubbs, C. L., and R. H. Rosenblatt
1961. Effects of the equatorial currents of the Pacific on the distribution of fishes and other marine animals. Tenth Pacific Sci. Congr., Abst. Sym. Papers. Honolulu, Hawaii, p. 340-341.

LaViolette, P. E., and S. E. Seim
1969. Monthly charts of mean, minimum and maximum sea surface temperature of the North Pacific Ocean. Spec. Publ. 123, Naval Oceanogr. Office, Washington, D.C., 58 p.

Nishiwaki, M., T. Kasuya, T. Kamiya, T. Tobayama, and M. Nakajima
1965. *Feresa attenuata* captured at the Pacific coast of Japan in 1963. Sci. Rep. Whales Res. Inst. Tokyo 19: 65-95.

Perrin, W. F.
1969. Using porpoise to catch tuna. World Fishing 18: 42-45.

Pryor, T., K. Pryor, and K. S. Norris
1965. Observations on a pygmy killer whale (*Feresa attenuata* Gray) from Hawaii. J. Mamm. 46: 450-461.

Rosenblatt, R. H, and B. W. Walker
1963. The marine shore-fishes of the Galápagos Islands. Calif. Acad. Sci. Occ. Papers 44: 97-106.

Scammon, C. M.
1874. The marine mammals of the northwestern coast of North America. Described and illustrated. Together with an account of the American whale fishery. G. P. Putnam's Sons, N.Y. 319 p. + v. Facsimile editions by Dover Pub., N.Y. (1968); and Manessier Pub. Co., Riverside, Calif. (1969).

Slijper, E. J.
1962. Whales. Basic Books, N.Y. 475 p.

Yamada, M.
1953. Contribution to the anatomy of the organ of hearing of whales. Sci. Rep. Whales Res. Inst. Tokyo 8: 1-80.
1954. An account of a rare porpoise, *Feresa* Gray from Japan. Sci. Rep. Whales Res. Inst. Tokyo 9: 59-88.

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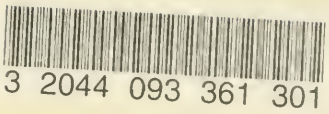
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